August 1925

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Electricity ~ Radio ~ Chemistry

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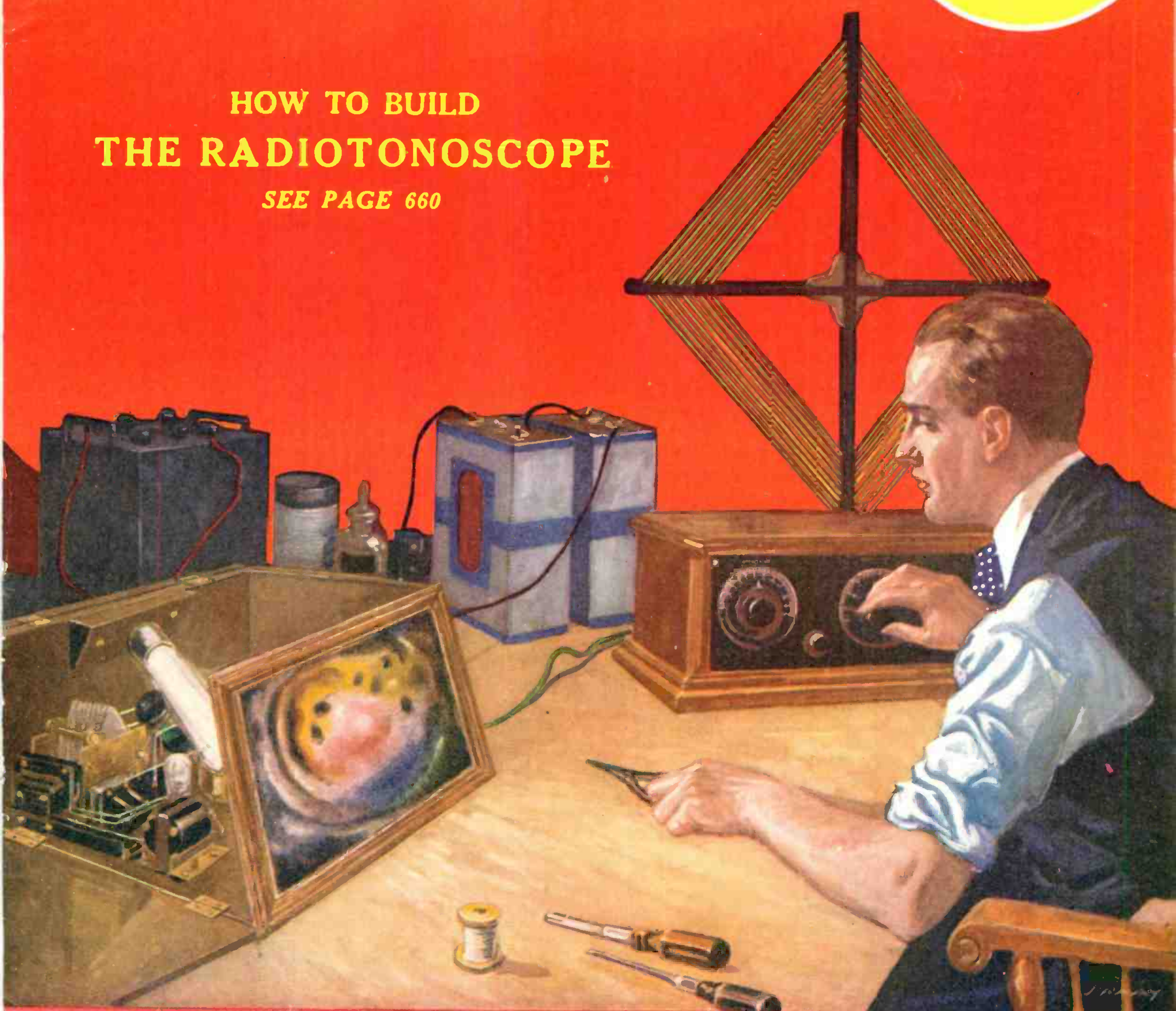

EXPERIMENTER PUBLISHING COMPANY, NEW YORK, PUBLISHERS OF

"Electricity Has Paid Me $301 for Every Dollar My Training Cost"

The Amazing Story of a Young Man Who Built a $10,000 a Year Income — and How He Did It

By ROBERT TODD

AMONG the many young men who have won big success in Electricity, few have had a more interesting career than Harold H. Hastings, President of the Hastings Electric Company, 312 Pine St., Bradentown, Fla.

In the fall of 1919 Hastings, just entering his fourth year at high school, decided he wanted to be an electrical man. He knew nothing about Electricity, being a farmer boy with no opportunities to study it. But he resolved to train himself, by spare-time study in his own home, for a place in the great and growing field of Electricity.

Through a friend he learned of the Chicago Engineering Works and of the home-study training in Practical Electricity conducted by its Chief Engineer, L. L. Cooke, a college-trained engineer of world-wide experience. Convinced that this was his one best means of securing the training he needed, Hastings enrolled for the Cooke Course.

His progress was astonishing. One month after he received his first lessons, he was doing Electrical jobs in his neighborhood, repairing doorbells and call systems, and earning about $10 a week after school hours.

L. L. COOKE, Chief Engineer, Chicago Engineering Works, who has trained Harold Hastings and thousands of others for big success in Electricity.

Two months later he did his first job of house wiring.

Two months after that, he was appointed School Electrician for the high school he was still attending, and for spending an hour or two a day taking care of the 20 call bells, the call system, and the 70 or more electric lights in the building, he was given a regular salary of $75 a month.

Eight months after he enrolled, Hastings received his L. L. Cooke Diploma, having completed the entire Course. The same month he graduated from High School. Then he started in business for himself as a Licensed Electrical Contractor.

Left, below—Harold Hastings on the job as an Electrical Contractor, supervising the wiring of a new house for electric lights.

Above — The Electrical Contractor in the office of his big Supply Store. Left —A "close-up" of Harold Hastings.

Inside of a year he was making from $12 to $20 a day and his reputation as a successful Electrical man had spread far and wide.

Today he owns one of the finest Electrical Supply Stores in the State of Florida, doing a monthly business of $3,000, with a stock valued at $12,000 and 10 men on his payroll. His concern, as he says, "does everything from wiring up a lamp to installing a power plant." In two weeks he supervised 32 wiring jobs and in the busy season he often outfits 20 houses in one day with electric fixtures. As Hastings says—"In the five years I have been in the Electrical game, I have made $24,000—over $301 for every dollar my electrical training cost me."

How Hastings Did It

I asked Hastings how he achieved such a big success—an income so far beyond what the average man ever hopes to earn—in such a short time. His face lit up with a smile as he replied, "I had no other training than what Mr. Cooke gave me. His Course made everything in electrical work plain and easy to understand. Mr. Cooke kept close tab on my progress, encouraged me along, and boosted me in my work even long after I had finished the Course and paid for it in full.

"Since becoming an Electrical Contractor I have employed many other Cooke-Trained Men, and I find they are all strong for the Chicago Engineering Works and L. L. Cooke.

"With Mr. Cooke's Course and advice, and a little pep of his own, any man cannot help but become a Big Pay Man in Electricity."

Do You Want To Succeed Like Hastings?

L. L. Cooke has become famous as a maker of Big-Pay Electrical Experts. Hundreds and hundreds of men trained by him now earn $3,500 to $10,000 a year—men with little or no knowledge of Electricity to begin with. If you are interested in Big Pay, send the coupon below to L. L. Cooke, Chief Engineer, Chicago Engineering Works, Dept. 21-C, 2150 Lawrence Avenue. Chicago, Illinois, for a copy of his big Electrical book and latest offer. Do this today and learn the way to big money in Electricity!

L. L. COOKE, Chief Engineer,
Chicago Engineering Works,
Dept. 21-C, 2150 Lawrence Ave., Chicago, Illinois.

Without obligating me in any way, please send me your big illustrated book on Electricity and tell me how I can be a Big-Pay Electrical Expert.

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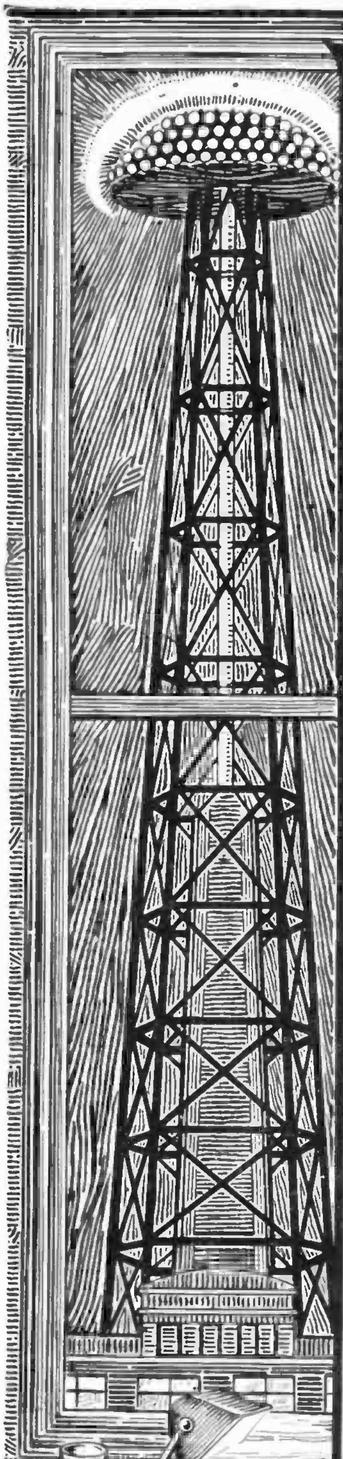

The EXPERIMENTER

Vol. 4 **Contents** No. 10

FOR AUGUST

IMPORTANT ARTICLES IN SEPTEMBER ISSUE

HIGH CAPACITY CHROMIC ACID BATTERY. This interesting battery is on the lines of the Volta pile. The solution is absorbed by a layer of spun glass and a constant feed by drops is given while the battery works.

RECENT DEVELOPMENTS IN TALKING MOTION PICTURES. This is an interesting paper from Germany indicating the recent progress made by our Teutonic friends in the line of talking movies—considered one of the great desiderata of the film.

BOMBARDMENT OF ATOMS. One of Jacques Boyer's luminous articles in line with the work of the most advanced scientists, opening the way to the transmutation of elements.

ALTERNATING CURRENT MOTORS ON DIRECT CURRENT. A very elaborate article by a high authority on this all-important subject which will answer questions often propounded without receiving any answer.

A SUCCESSFUL THREE-STAGE AMPLIFIER. Full details of the construction of a variable impedance to be used with three steps of transformer coupled audio frequency amplification.

HOW TO MAKE A TOROID COIL. Toroid coils have found extensive use in sets where the existence of an external field from a coil would cause considerable trouble. The toroid having no external field, its usefulness is great.

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NAME	ADDRESS (Street—City—State)	List here specific article on which you wish literature.	If Catalogue of complete line is wanted check in this column.

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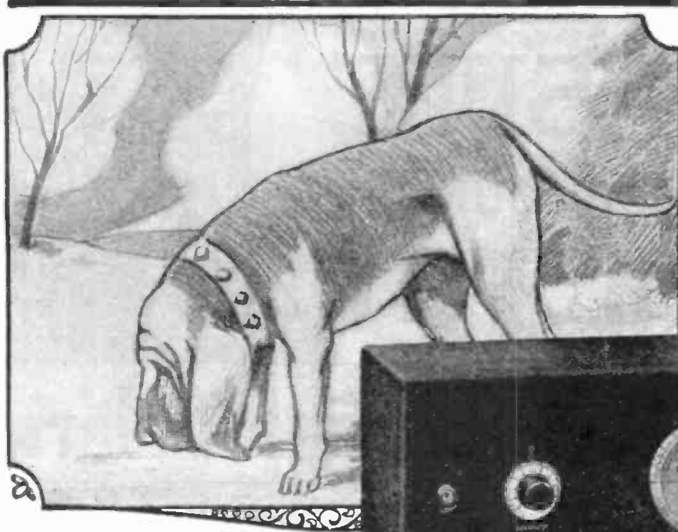
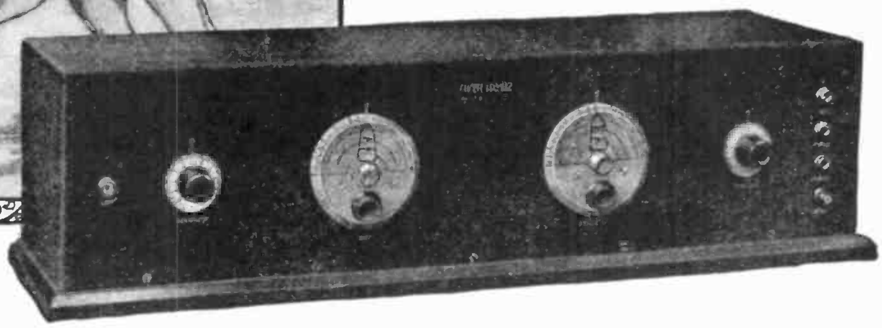
8-25

Sensitivity



The bloodhound, remarkable for the acuteness of its smell, can pick up a scent and follow a trail when all else fails.



-never before thought possible!

With the extreme acuteness of the bloodhound's scent, the Model L-2 Ultradyne detects the faintest broadcast signals—signals that are "dead" to other receivers—regenerates and makes them audible on the loud speaker.

It's here, where the development of other super-radio receivers has halted; the Ultradyne forges ahead.

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Do you remember how the tales of pirate gold used to fire your imagination and make you want to sail the uncharted seas in search of treasure and adventure? And then you would regret that such things were no longer done. But that is a mistake. They *are* done—today and everyday—not on desert islands, but in the chemical laboratories throughout your own country. Quietly, systematically, the chemist works. His work is difficult, but more adventurous than the blood-curdling deeds of the Spanish Main. Instead of meeting an early and violent death on some forgotten shore, he gathers wealth and honor through his invaluable contributions to humanity. Alfred Nobel, the Swedish chemist who invented dynamite, made so many millions that the income alone from his bequests provides five $40,000 prizes every year for the advancement of science and peace. C. M. Hall, the chemist who discovered how to manufacture aluminum made millions through this discovery. F. G. Cottrell, who devised a valuable process for recovering the waste from flue gases, James Gayley, who showed how to save enormous losses in steel manufacture, L. H. Baekeland, who invented Bakelite—these are only a few of the men to whom fortunes have come through their chemical achievements

What Some of Our Students Say of This Course:

I have not written since I received the big set I can still say that it far exceeded my anticipations. Since I have been studying with your school I have been appointed chemist for the Scranton Coal Co. testing all the coal and ash by proximate analysis. The lessons are helping me wonderfully, and the interesting way in which they are written makes me wait patiently for each lesson.—MORLAIS COUZENS.

I wish to express my appreciation of your prompt reply to my letter and to the recommendation to the General Electric Co. I intend to start the student engineering course at the works. This is somewhat along electrical lines, but the fact that I had a recommendation from a reliable school no doubt had considerable influence in helping me to secure the job.—H. VAN BENTHUYSEN.

So far I've been more than pleased with your course and am still doing nicely. I hope to be your honor graduate this year.—J. M. NORKUS, JR.

I find your course excellent and your instruction, truthfully, the clearest and best assembled I have ever taken, and yours is the fifth one I've studied.—JAMES J. KELLY.

From the time I was having Chemistry it has never been thus explained to me as it is now. I am recommending you highly to my friends, and urging them to become members of such an organization.—CHARLES BENJAMIN.

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I am more than pleased. You dig right in from the start. I am going to get somewhere with this course. I am so glad that I found you.—A. A. CAMERON.

I use your lessons constantly as I find it more thorough than most text books I can secure.—WM. H. TIBBS.

Thanking you for your lessons, which I find not only clear and concise, but wonderfully interesting. I am—ROBT. H. TRAYLOR.

I received employment in the Consolidated Gas. Co. I appreciate very much the good service of the school when a recommendation was asked for.—JOS. DECKER.

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No. 10

The EXPERIMENTER
Electricity ~ Radio ~ Chemistry

August
1925

H. GERNSBACK, *Editor and Publisher* T. O'CONOR SLOANE, *Ph.D., Associate Editor*

Courage in Experimenting

By Hugo Gernsback

"An ounce of experimenting is worth a pound of theorizing"

THE EXPERIMENTER, in nearly all cases, is a pioneer and as such usually has all the good qualities of such a personality. When you venture out into uncharted wilds, whether it be in the forest or the laboratory, you must possess a certain amount of courage.

In the laboratory, the chemical experimenter possibly requires the greatest courage, because his work very often is dangerous and he never knows what may happen.

The electrical experimenter, also, when handling high voltages, not infrequently endangers himself. When Tesla, not so many years ago, made his historic experiments in man-made lightning, in Colorado, he never knew what might befall him next. He literally took his life into his hands in the interests of Science, but, like many other successful pioneers, he came through unscathed. Here was a case where an experimenter went forth into an absolute wilderness of things entirely untried and of unprecedented qualities, and courage of the highest order was required to bring these experiments to a successful conclusion.

Even the radio experimenter does not always lead a prosaic existence. The young experimenter, when trying out a new and special kind of aerial, finds it necessary to do some hazardous climbing about on roof tops and trees, that is not always pleasant. In the laboratory many things may occur, particularly to the modern experimenter who works with ultra short waves. The properties of these waves are not as yet understood, and we do not know even now whether such waves are harmful to the human being, as are X-rays, or if they are innocuous.

Recently that famous experimenter, John H. Reinartz, discovered many important new phenomena by using short waves, and was enabled to render solid metal plates transparent. He may or may not have been aware that such experiments are dangerous, and, as a matter of fact, he asserted that we do not know whether they are or not. But the point to remember is that when delving into uncharted regions, we never know what may happen.

The above refers to one sort of courage that is needed by the experimenter and which he must possess. There is, however, an entirely different sort of courage that is far more important, far more trying, and, while it does not endanger one physically, it is the sort of courage found only in the most intrepid. It is simply this:

THE COURAGE REQUIRED TO PERFORM AN EXPERIMENT CONTRARY TO ALL REASON.

We are all more or less inclined to tread the beaten path. We learn different things by experience and we become so steeped in the knowledge of them that it becomes almost impossible to unlearn them. We become imprisoned, so to speak, in a sort of treadmill, like a squirrel in his cage, from which we find it impossible to liberate ourselves after too long delaying there. We have learned that two and two are four, but we cannot comprehend that on the planet Mars two and two might not make four, but something quite different. The same is the case in experimenting. We go along and mix certain chemicals in a certain manner, because we have been taught to do so. Very seldom do we wish to vary this sort of thing and try the impossible. This takes courage.

For many years text books all over the world, printed in all languages, laid down the axiom that an electrical current needed a conductor to carry it along. If Herz, the first inventor of wireless, had taken this statement in full literalness, we might not today have the science of radio. It required courage of the highest order to disbelieve this axiom, and start along a new and original line of experimenting, in which he proved that the electric current *could* flow in open space and did not need a conductor.

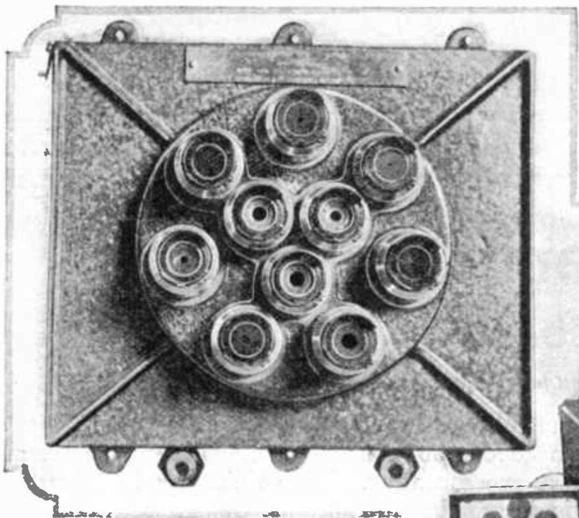
We have been taught for many years that a burning body will sooner or later be consumed, leaving nothing behind it. Edison wanted a filament for his incandescent lamp. Like experimenters before him, he had tried platinum without success from the practical standpoint; it gave light, of course, but would melt too easily. So as a material for a filament, to be kept at a white heat for hours at a time, he selected one of the most combustible substances known, namely carbon. Platinum was non-combustible, but would melt. Carbon would not melt, but was very combustible. A filament of carbon ignited in the air would not last a fraction of a second, so he selected this impossible filament of the impossible carbon for his lamp, shut it up in a cage, as it were, and exhausted the air from the glass bulb containing it. Then he ignited it by a current of electricity, lit up Menlo Park with it, and the story of his early work of effecting the impossible in making the impossible lamp with the impossible filament that did service for a generation, reads like a romance. It took definite courage to select so absurd a substance as a thin filament of combustible carbon to be ignited to white heat and to give out light for hour after hour.

When Bell placed his iron diaphragm in front of an electromagnet and had somebody speak into a similar contrivance at the other end, he must have had great moral courage to attempt such a foolish experiment, because there was absolutely no reason, in those times, why the thing should work at all and why intelligible words should be uttered from a rusty piece of iron sheeting.

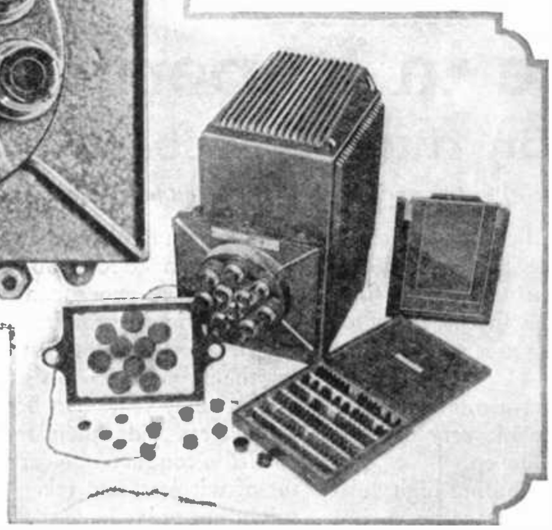
Most experimenters are of the mentality in which they say to themselves, "Well, it is not worth while trying to make this experiment. It won't work." If the majority of us did not reason along these lines, perhaps more important inventions and discoveries would be made. The writer repeats that it takes a tremendous amount of courage to perform an experiment that looks incredible, sounds incredible, and seems to be foredoomed.

Of course, not all such experiments come out successfully. Most of them do not, but it is worth while to follow all impossible experiments through to the end. Something may come of the most improbable of them.

The Mutochrome—A New Color Machine



Front of the new color machine the Mutochrome. The machine comprises a battery of lenses, each provided with a prism. With vari-colored filters an almost unlimited number of color effects are possible.



Below: The Mutochrome open; a box of color screens and the set of iris diaphragms.

A RECENT British invention called the Mutochrome, serving the double purpose of color experimentation for studying designs and photographing the different component elements of the design for later coloration, has just been placed on the market.

The Mutochrome is the invention of C. F. Smith, of the technical staff of Adam Gilbert, Ltd., manufacturers of optical and scientific machines. Essentially, the instrument consists of a battery of lenses placed in a circle closely together with provision made for the insertion of vari-colored filters for each lens, which arrangement provides an almost endless color scheme.

As a camera, the apparatus is employed to photograph the pattern or design whose best color scheme is to be determined. One photographic plate in the ten-lens machine will accommodate ten separate photos, one for each lens, which portray the various stages in the building up of the design-pattern. The process for taking these various photos is simple. Having properly adjusted for the focal length of the lenses and the iris diaphragm in front of them, caps are placed over the lenses to prevent light from passing through. The camera is loaded with a fresh plate, and the first stage of the design is then photographed directly.

Only one lens is uncovered to take this picture. Then, as can readily be understood, a second lens is used to photograph the second portion of the design and so on, each section of the design being superimposed on the other in exactly the same spot. As can be seen in the photograph, the exposures are very small ones, each separated by a sufficient distance to prevent overlapping. The plate, after all exposures have been taken, is developed in the regular manner and inserted into its same relative position.

By reference to the diagram, we see a five-stage design pattern. Step 1 shows a part of the design transparent. This is the part which is to be projected in any desired color. The rest of the slide is carefully painted over with heavy white or other opaque medium. Part 2 is similarly treated, as are the rest of them. Heavy dobs of pitch are painted around the edges of the negatives as protection. In projection upon the screen, the parts of the design are superimposed upon each other, all registering as accurately as possible, and we see if no color screen is used, a pure white background with black lines outlining the design. The introduction of one color affects but one part and thus a veritable building up process results.

It can readily be seen that the number of color combinations possible is practically unlimited.

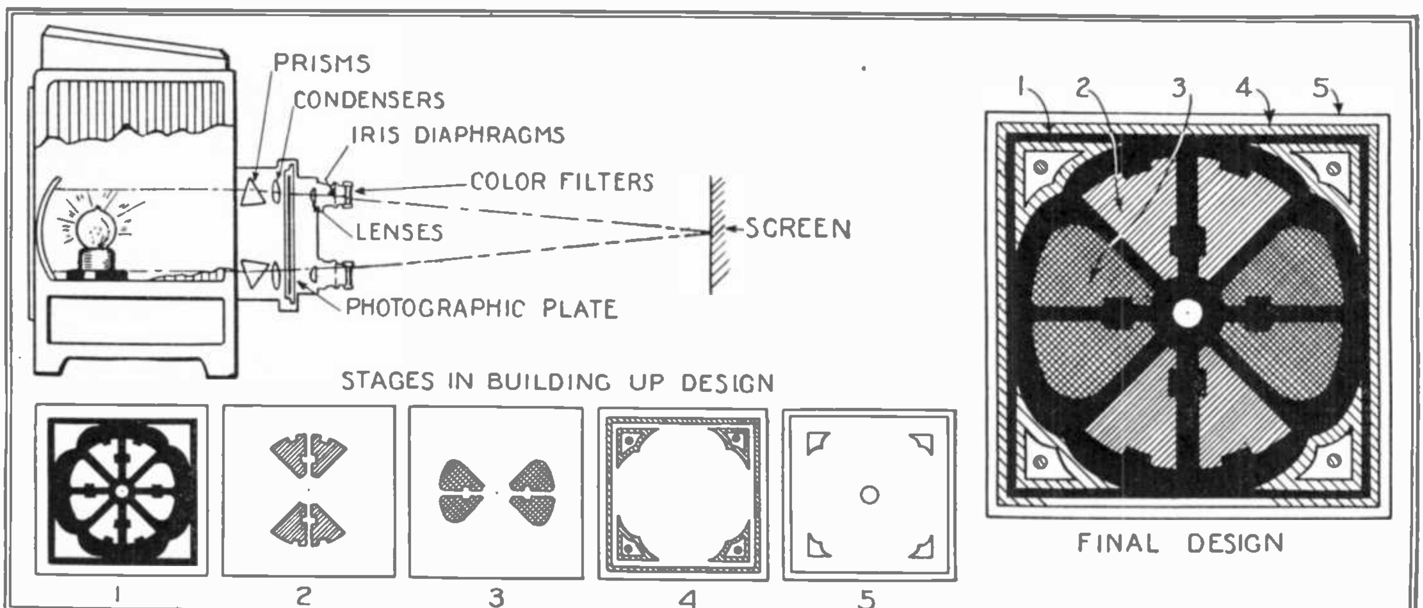
Then subsequently, using the machine as a projector, each lens projects its own image on the wall and the elements mesh into a realistically colored picture, when color filters of various shades are interposed between the lenses and screen.

Thus, in the case of a pattern made up of peonies or roses, leaves, buds and a background, one lens will project the flowers, another the buds, a third the leaves and a fourth the background. The result is, of course, obvious. The coloration can be made such as to please the most critical and fastidious eye.

Any elements of the design can be colored by the insertion of a filter in front of the corresponding lens, and by the adjustment of the iris diaphragm the brightness or depth of the color can be controlled.

Ordinarily, without the use of filters, one would see the design thrown on the screen in black and white, but by the correct choice of the proper filters, any color arrangement can be had. The filters consist of two pieces of optically worked glass with dyed gelatine between them. This gives a positive permanent color screen. The colors are graduated and placed in a small box according to their value. They are graded according to the spectrum, and when it is desired to alter the tone value of any of them, two, three or four filters may be placed in front of the same lens, thus allowing for the building up of an almost unlimited variation of color tone.

The range of color filters supplied with the instrument comprises three each of seven-



Showing how a design is thrown on the screen in successive stages. As an example, a five-stage design is shown. Each step is produced by a separate lens which can be shaded with any color desired. The final design can be seen to the right and its color scheme can be changed to suit even the most fastidious. The iris diaphragms provide an excellent medium for changing the intensity of the colors produced by the insertion of various filters.

Telegraphic Transmission of X-Ray Photographs of Injuries

QUICK X-ray diagnosis by eminent specialists have been made possible by transmission of X-ray photographs by wire. A negative showing the bone structure of

Photograph from the original X-ray negative of a hand with a ring on the finger.

the human hand was sent from New York to Chicago in seven minutes on Wednesday, April 15.

We quote from an X-ray authority:

"The time element in the diagnosis of an injury or ailment by a specialist is most important. In complicated fractures or other bone injuries a quick diagnosis is invariably desirable in order to prevent infection or other complications. A saving of hours or days means everything to the patient."

During the recent tornado in the Middle West, a woman received a severe fracture of the knee. The medical men available, who were not X-ray specialists, were unable to treat her, and it was necessary to take her to New York. If an X-ray photographic negative could have been sent by wire, a specialist would have been able to reply immediately with instructions for preventing permanent lameness or other complications without the necessity of the patient going to New York. The possibility of sending such negatives by wire brings the specialist to the small community.

Dr. D. W. Coolidge, of the General Electric Company, has perfected a portable X-ray equipment, already illustrated in our columns, which a doctor can use anywhere by connecting it with the household lighting circuit. These widely-used outfits have eliminated the necessity of moving a patient to a hospital for X-ray examination, and now electrical transmission of photographs indicates that soon it will not be necessary to take patients to large cities in order that the services of specialists be available.

Dr. J. M. Steiner, of Roosevelt Hospital of this city, writes:

"Medical consultation between doctors on X-ray plates transmitted by radio or telegraph is a realization that should find a most useful place in these progressive times. The quick transmission obtained by this method should afford untold satisfaction to both the consultant doctor and the anxious family. In New York hospitals, we frequently have patients who are either injured or taken ill while traveling. These patients, being in strange hands, naturally desire their home physician in consultation. If explicit information could be quickly transmitted to the home physician, much needless travel could be avoided.

"Many times physicians desiring an opinion from a distant consultant, could materially shorten a tedious delay if X-ray plates were quickly transmitted by telegraph to such consultant, who in turn could render an opinion within an hour or two where otherwise several days to a week or more might be involved. Written descriptions or word pictures even of such simple conditions as fractures are often most misleading, whereas the actual conditions shown graphically by X-ray plates are more convincing."

The present achievement of the transmission of X-ray photographs by wire marks an important step in the progress of X-ray diagnosis. The first practical application of the Roentgen ray in medicine or surgery was in the detection of foreign bodies. Foreign bodies in the tissues or the elementary, respiratory or urinary tract may be readily observed, but their localization, that is the determination of their actual position in the

Photograph from the positive which is printed from an untouched negative as received by wire in Chicago from New York.

body, is a problem that requires skillful technique in observation. Another important use of X-ray photographs, or as they are preferably called radiographs, is found in the diagnosis and treatment of fracture. This application has become almost universal.

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EDITOR.

The Mutochrome—A New Color Machine

(Continued from preceding page)

teen bright colors covering the whole spectrum, three each of thirteen pale colors covering a similar range, and three which give a daylight effect and serve as a correction for the warm yellow-orange color of the artificial light used for projection. It is forcibly drawn to the attention that this experiment with the color filters serves the same purpose as is accomplished when an artist prepares a series of differently colored sketches for the same design. How much simpler, how much less expensive, and how much less time required for the selection of the best color scheme!

The machine has a wide range for application in industrial lines. It can be used in determining color schemes for wall paper, fabrics, dress goods, linoleum, rugs and carpets, textiles and silk.

One advantage suggested in favor of the instrument is that the coloring and tonal gradation can be changed much more rapidly than can be done with paint on paper, and another is that a satisfactory combination having been finally arrived at, the exact appearance on the textile for which it has been planned can be determined by projecting directly upon the fabric. The color design, projected upon a piece of silk, gives exactly the effects of a printed silk.

To match up the colorings arrived at through the machine with those employed in the particular industry under consideration, some preliminary work to correlate the numbered filters with the existing color range at the plant is suggested. Otherwise, colors can be matched against the projected picture. Lens caps make it possible to isolate temporarily any one shade that is to be matched by shutting off all the others.

The standard 10-picture Mutochrome enables ten elements of a design to be varied independently at a distance of three feet. The size of the picture at this distance is approximately eighteen inches square.

The Mutochrome may be used to solve numerous practical problems on coloration which may arise, as well as to demonstrate many color phenomena of mainly academic interest.

As an example, a number of lenses can be made to project separate small squares side by side in contact. By placing similar filters in each of these lenses and suitably adjusting the iris diaphragms, a perfect series of tones of the same hue from the pure color down to black may readily be obtained. Such a series is physically perfect in that the dominant hue is constant throughout, the only variation being in luminosity. Similarly, if each square is projected by two lenses, another series can be built up by varying dilutions with white light.

The Mutochrome provides an excellent colorimeter to be used as a standard in comparing various colors and in analyzing them. Other applications will occur to the colorist as soon as one becomes familiar with the principles and possibilities of the instrument.

The Tungsten Arc Lamp

By Dr. Franz Skaupy

THE tungsten arc lamp consists of a hermetically sealed incandescent lamp bulb containing an inactive gas and with two or more electrodes, consisting essentially of tungsten, which are brought to high incandescence by an electric arc so as to give out intense light.

The difference between it and the carbon arc lamp lies in the substitution of tungsten as a light giving electrode by inclosing it all in a hermetically sealed, incandescent, lamp bulb; and by the absence of feeding electrodes; while it differs from the incandescent lamp only by the way in which the light-giving body is heated.

According to the kind of lamp the fall of potential takes place at the cothode or at the anode, preferably at the light-producing electrode.

It is known that between two electrodes with terminals close together in an atmosphere of gas, an arc will not form unless some special action takes place; in other words, it must first be lighted or "struck." As the starting of the arc in these lamps

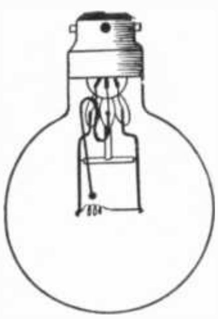


FIG. 1
Pointolite lamp of the Edison Swan Electric Co. with a spherical anode of tungsten. It is lighted by ionization.

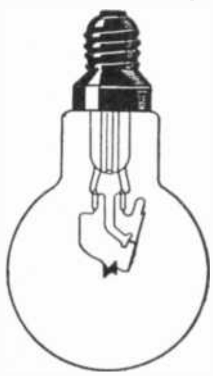


FIG. 3
Osram Point Light lamp filled with nitrogen for direct current; it operates by mechanical ignition.

is the principal point of difficulty in their technical evolution, the various known types are to be distinguished principally by the way in which the arc is struck, this can be used to give us the divisions under which the different lamps may fall.

Today we can distinguish four kinds of lighting or striking of the arc:

1. Lighting by ionization. Here a conductor, connected close to the location of the arc within the bulb, is brought to incandescence by the passage of a current. The electrons emitted ionize the gas in the bulb and start the arc.

2. High frequency lighting. A high potential spark is discharged for an instant through the lamp. This heats the electrode and ionizes the gas, so that the arc can spring across, actuated by the high momentary potential.

3. Lighting by mechanical movement. The electrodes to be moved when the current is turned on are drawn apart by an automatically working mechanism just as in the regular carbon arc lamp.

4. Glim lighting. Here by proper choice of the gas to be contained in the bulb and by giving it a proper pressure, a glim light is produced on connection with the main lighting circuit, which instantly is replaced by the desired arc lamp and disappears.

The first commercial tungsten arc lamp placed on the market was the Pointolite lamp of the Edison-Swan Electric Company of London. This worked by ionic starting and was filled with nitrogen up to a pressure of about 6 inches of mercury. The illustration, Fig. 1, shows such a lamp with a spherical terminal anode of tungsten, where the light is really produced. The cathode, which gives but little light, is a tube of tungsten mixed with an oxide adapted to favoring emission of ions, generally thorium oxide. The little tube is carried by a tungsten wire passing through it, which outside of the tube is bent into a spiral. Referring to Fig. 2, the current first goes through the tungsten wire and heats the spiral to such a degree that it emits electrons and for the moment becomes the cathode of an arc. But this immediately ceases and the proper cathode, the little tube just described, takes its place and the circuit which heated the spiral is short-circuited.

The disadvantage of this lamp is the necessity of providing two pairs of leads and therefore special sockets and bases for the lamps; its lighting is not always certain, and the spiral of tungsten wire is delicate and can easily be burned out. The cut-out arrangement for the heating element also complicates the operation of the lamp. Pointolite lamps up to a power of 1,000 candles were put on the market, the more powerful ones with construction and lighting arrangements still more complicated than in the smaller types.

In the last year the Osram Company of Germany brought out new self-lighting types of tungsten arc lamps, called the Osram Point Light Lamp. The direct current type of this lamp, filled with nitrogen, operated at potentials of 100 volts upward, and a current strength of 1, 3 and 4 amperes, using the principle of mechanical motion for the lighting; it is shown in Fig. 3. The cathode, when the current is turned on, operates as a spring upon the anode, which is to give the light, and which in the smaller type is a little sphere and in the larger type a hemisphere of tungsten.

A compound bar connected to the rod carrying the cathode is heated by the passage of the current and raises the cathode from the anode so as to start an arc. Anode and cathode are in contact when no current is passing, as it will be understood that the cathode and anode have hitherto been in contact. The lamp, therefore, has only one pair of current connections, and is adapted for the regular socket used for incandescent lamps. The lighting requires only a few seconds, and when the current is turned off only a short period is required before the anode goes back to its original place and the lamp is once more ready to be lighted. The brightness of the anode, which here is the real producer of the light, is about 15 candles to the square millimeter. The candle-

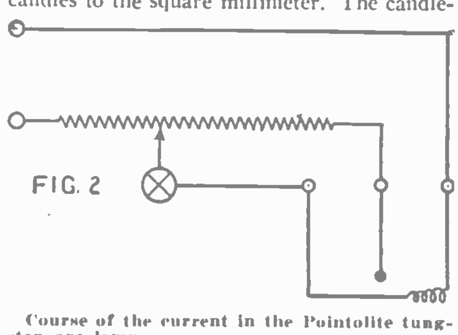


FIG. 2
Course of the current in the Pointolite tungsten arc lamp.

power of the two types are 80 and 300 candles, with a consumption in watts of about 65 and 200 watts. This does not include the current used in overcoming the resistance of the lamp connections. A difference of potential between the connections of about 50 volts is brought about with rarefied nitrogen. Every lamp has its own proper resistance to be switched into series with it. Constant resistances inclosed in a lamp bulb filled with hydrogen can be employed.

And now we come to another type of lamp which is only adapted for alternating current. One of these is shown in Fig. 4. The

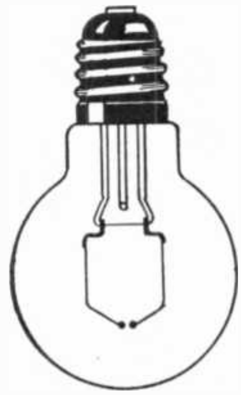


FIG. 4
Tungsten arc lamp for alternating current connection; it is filled with neon and arranged for glim ignition to start the arc.

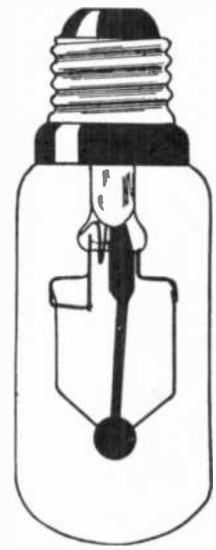


FIG. 5
Tungsten arc lamp for direct and alternating current lighting with nitrogen filling; an example of "bridge lighting."

difference between this type and what we have described is largely in the filling, which is of neon gas at the pressure of more than one-half an atmosphere. The neon gas makes possible, on account of its low resistance to the electric discharge, what has been designated as glim lighting. If such lamps in circuit with a proper resistance are connected to an alternating circuit of 220 volts, they will light automatically. Two little spheres of tungsten are used for the two electrodes which are maintained at a short distance apart. When the current is turned on, electrodes and their connecting wires first show the familiar reddish glim light, which quickly disappears, simultaneously with the striking of the arc. The candlepower and watt consumption of both types may be given as 40 candles and 32 watts in one, and 100 candles and 65 watts in the other.

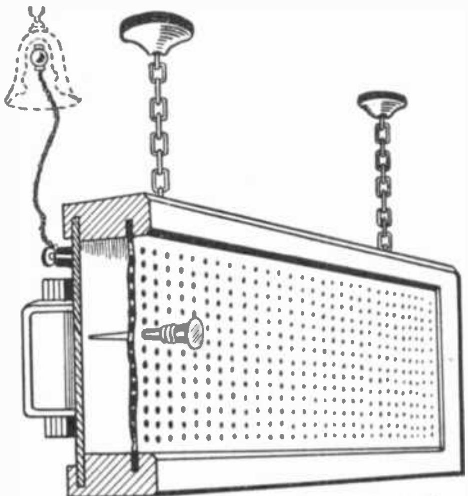
On the other hand, as a general rule, only the light of one of the electrodes is practically useful in any one direction. The potential difference between the lamp terminals is only about 25 volts, so that the greater part of the potential of the circuit must be cut down by a choke coil in series with the lamp. This of course uses up very little energy.

The Osram Point Light lamps for direct current last about four hundred hours. The alternating current lamps last about half as long. Their short life is due to the exhaustion of the tungsten of the arc electrode and the blackening of the glass bulb incident thereto.

Lately the Osram Company has succeeded in producing a lamp operating on direct as well as on alternating current. It is filled with nitrogen and the method of lighting is a special case of mechanical ignition which can be designated as bridge lighting; as a connection between both electrodes is drawn away by the lighting process, first from one and then from the other electrode. This

(Continued on page 706)

Luminous Signs with Changeable Text



Electric sign. Lamps carried on spindles are connected through the holes in the perforated front piece so as to form any desired design or inscription.

TODAY the luminous sign is to be seen everywhere; it adds many charms and even animation to the arteries of all cities of any importance. If the electric sign were suddenly suppressed, something would be felt to be wanting which is essential to our streets.

There is always an inconvenience common to signs of all kinds which is that it is difficult to modify them except at a high cost. Now modern business has a horror of uniformity and constantly is on the watch to renew its modes of publicity, so as better to attract the curiosity of the public and fix its attention.

The luminous Phal sign gives precisely the means of satisfying this desire for novelty and at the same time effects serious economies in the electric current. Externally, it takes the shape of a tablet or sign into which small electric lamps with opalescent or reflecting bulbs are thrust; in placing the lamps in proper position, letters are formed and any text can be given as desired.

We may examine more closely the construction of this tablet. It is composed of a sheet of metal with regular holes drilled through it mounted in a wooden frame. In this same frame at a few inches distance back of the metal sheet there is a second one, but with indentations instead of holes. The bulbs are mounted on special bases, whose end and central electrode is formed by a little bar with a long point; it will be seen at once that the two metallic sheets form two electrodes of a lighting circuit. One of the poles of the lamp is in contact with the first named or outer sheet of metal by its metallic base; the other pole by the pointed rod, its central electrode, which connects with the sheet at the rear with its fine indentations, completes the connection.

The lamps used are the ordinary flashlight bulbs which work at a potential of about 3½ volts. It is known that the lowest consumption of current for a given light is produced at low voltage. The potential of the circuit, which is in the neighborhood of 110 volts, must be reduced. A transformer will effect this reduction, assuming that the current available is an alternating one, which is more and more the case every day. The consumption of current for such a sign is very slight, 100 watts for 20 letters, and the installation is of the highest degree of simplicity. By a flexible cord with plug the lamps can be connected to a wall socket or other place so that the signs can be moved around *ad libitum*.

Above. One of the lamps as carried by the spindle for insertion in any desired part of the diaphragm.

Below. Example of a sign as prepared by this apparatus.

Luminous Night Signals without Lamp

By Jean Montfort

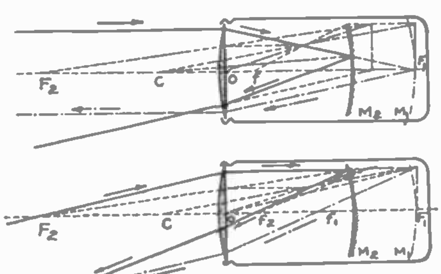
NIGHT signaling on roads, a subject which acquires a greater and greater importance, on account of the increasing number of vehicles of all sorts, especially automobiles, and on the other hand because of the ever increasing speed of such vehicles, can be considered under two aspects; it is either designed to give simple indications of direction, names of villages, etc., or else it is intended to insure safety by warning the automobilists of obstacles and dangers which they may meet, such as grade crossings, bad turns, and other features of the road.

It is evidently the last problem which is of the greater urgency, and for which no really efficacious solution has yet been presented.

As far as indicating signs, so useful by day, are concerned, it is fair to say that they are barely visible at night, in spite of the powerful electric lamps carried by modern automobiles, because the light, as they receive it, is scattered in all directions, and the automobilist only seeing a small part of the sign cannot read the whole inscription or understand the signals.

Again, as the surfaces of the signs always are more or less polished, the light is not uniformly diffused. It goes off with more intensity in one particular direction, depending on the path of the beam of light which impinges on it, which is rarely reflected back to the driver of the car. It seems then that a good solution of the problem of night signals would be realized by an optical construction, which for an angle of incidence varying over a considerable range would reflect all the light received by the sign in a single direction, and one which would coincide so closely with that of the beams from the automobile that its occupant could read the inscription.

There is one thing to be noted. If the beam is sent back precisely in the direction of its origin, the eye could not receive it, unless it was on the exact focal axis of the light emitted an impossible case, because the driver must be at an appreciable distance from his headlight. It is then necessary to send towards the source of light a beam not rigorously parallel with the impinging one, but slightly divergent.



The upper diagram shows the course of the rays in the Cataphote when the original light is parallel to the axis. The lower shows their course when the light entering is not parallel thereto. The arrows show the course of the light and similar letters are used in both. M_1 is the locus of the focal plane of lens o, and M_2 indicates the position of the mirror out of focus, the departure from the focus being greatly exaggerated for the sake of clearness.

Such is our problem. We can now appreciate the advantages of the arrangement for night signalling, which was invented before the war by M. Henri Chretien, Astronomer in the Nice Observatory, consisting of a modification of the Fizeau Self Collimating Mirror which is the mirror invented by the eminent astronomer for his researches on the velocity of light. This arrangement has been tried practically by M. Garbarini. There is a tube 1 inch in diameter and 1¾ inches long; at one extremity there is a plano-convex lens with a focal distance of 1⅝ inches. A little in advance of the focus of the lens, about 1/32-inch, there is a concave spherical mirror whose radius of curvature is equal to the focal length of the lens.

We may consider the course of the luminous rays in this optical system first in the case of a beam parallel to the axis of the apparatus, and then for a beam not parallel thereto. The diagrams show that the reflected beam is slightly divergent and the caption explains the features.

Experience shows that letters formed by these reflectors on a signboard appear very brilliant at more than half a mile distant if they receive the light from an automobile. The divergence is enough so that at 50 yards an eye some 30 inches above the level of the lamp, which is the case in automobiles, receives a reflected beam. The field for the utilization of the apparatus is a broad one. Signals arranged as described can be placed at 10 or 12 yards from the line of the road and yet will be perfectly visible.

Evidently there are many applications of these perfected reflectors. All the features of a route can be thus signalled in a perfectly definite manner. Some grade crossings are already protected by a barrier composed of these reflectors which the French call "cataphotes," which is the name the inventor has given to the apparatus whose lens is colored by a special red pigment. Bicyclists will find in the use of "cataphotes" a protection much greater than that of the present arrangement. The red tail light on cars would be always visible even if the lamp were out, if a "cataphote" were in its place or near it. Notice boards placed along the roadside and across the center of a road would become luminous as each car passed them without their lighting costing a cent. Its use for aviation can be seen in order to give signals at night; the names of villages beneath the airplane may be shown by means of letters formed of "cataphotes." Special short focus apparatus presenting a large divergence of rays could be used in city advertisements, because the light present everywhere in a large city is sufficient to illuminate the "cataphote."

(*Translated from Science et la Vie*)

EXPERIMENTAL RADIO

CONDUCTED BY LEON L. ADELMAN

How To Make the Radio Tonoscope

By William Grunstein, E.E.

THE visual representation of sound has always been an attractive subject of experiment. Numerous attempts have been made in the past to represent musical tones by colors. In spite of a large number of devices that give this effect more or less successfully the subject is not yet exhausted and in this brief article we offer suggestions for the construction of a new type of such apparatus.

The device to be described is designed to be mounted in a cabinet and operated in connection with a radio receiving set. The apparatus when properly functioning should cast a colored pattern on a ground glass observation plate. With the changes in musical tone or in speech coming in on the receiver, the pattern and its colors will change.

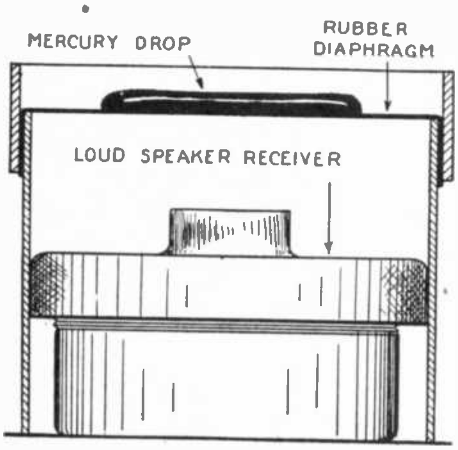


Fig. 1

Fascinating patterns of stationary waves will be set up in a drop of mercury placed on a rubber diaphragm stretched over the loud speaker receiver, when the latter is in action.

The essential feature of the apparatus we owe to the English experimenter, E. E. Fournier d'Albé. A rubber diaphragm (Fig. 1) is stretched over a loud speaker receiver and on this diaphragm a large drop of mercury is placed. When the receiver is actuated, the sound waves emitted by it set the mercury drop into vibration. These vibrations are in the nature of wave motions proceeding from the periphery of the drop towards the center, where they are reflected and sent outwards. The reflected waves and those advancing towards the center interfere and set up the so-called stationary waves. These waves will form very curious and fascinating patterns on the surface of the drop. Each pattern exactly corresponds to a particular frequency of vibration.

The surface of mercury is highly reflective and a beam of light thrown upon it will be reflected with almost undiminished intensity. In Fig. 2 one arrangement for the projection of these mercury drop patterns is indicated. When viewed by white light, a pattern will appear in black and white as shown in the photographs in Fig. 3. It is important that no direct light should fall on the ground glass plate. To insure this the source of light may be mounted in a telescoping cylinder with a projecting lens, as in Fig. 2.

A drop of mercury set in vibration by sound waves will form stationary waves which are arranged in patterns such as those shown at the right.

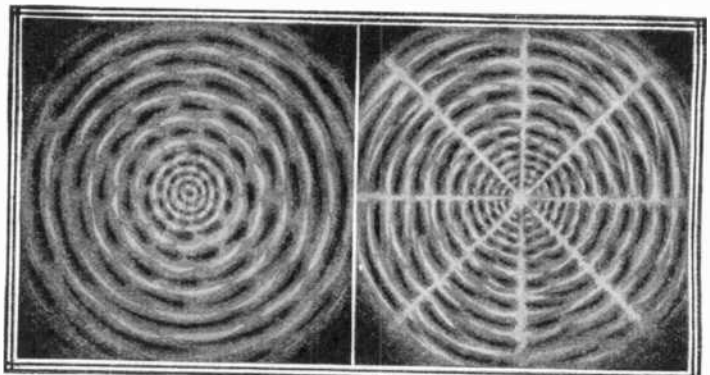


Fig. 3

A somewhat more elaborate and probably more effective arrangement is represented in Fig. 4. Here the incident and reflected beam on the mercury surface is almost perpendicular. This effect is achieved by two mirrors mounted so as to be adjustable to any angle. One mirror receives the light from the source and reflects it on the mercury drop, while the other receives the beam reflected from the mercury and projects it upon the ground glass plate. Both these arrangements can be mounted in a neat cabinet large enough to receive some other apparatus to be described later.

This device will operate very effectively and its usefulness has been demonstrated by Mr. Fournier d'Albé who has made repeated use of it as a test for tone quality by comparing the pattern photographs taken from tuning forks with the patterns produced by the singing voice.

To make the device more attractive, the experimenter might try to develop means for giving colored impressions of these patterns in such a way that the color of the pattern will change at the same time as its form. We leave the development of such arrangement to the ingenuity of the experimenter, but in order to suggest a line of research we will describe one form of such device that seems practicable.

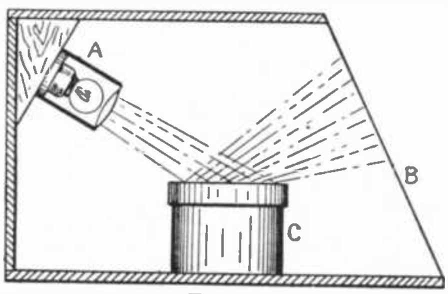


Fig. 2.

Means for projecting mercury drop patterns on a ground glass plate. (A), Projecting light. (C), Mercury drop and loud speaker as shown in figure above. (B), Ground glass plate on which the reflected pattern falls.

Instead of using one lamp as indicated in Figs. 2 and 4 the experimenter might make use of three very low resistance colored incandescent bulbs. Each of these bulbs is to be connected in a tuned circuit of audio frequency consisting of one winding of a transformer and a large capacity condenser. Such an arrangement is indicated in Fig. 5. The transformers are arranged to step-down the voltage so as to increase the current in the tuned circuit, so the usual second winding is here used as primary and connected in the output circuit of a push-pull amplifier.

The three windings are connected in parallel with a center tap from each winding. The three lamps may be colored red, yellow and blue and the condensers adjusted to such capacity as to tune each of the three circuits to a different frequency, each within the audio frequency band. With such arrangement it is expected that as the frequency of the output current of the receiver changes, one or the other of these bulbs will light to maximum intensity and so the illumination may vary from a preponderating red, blue or yellow to any blending of these. If the experimenter succeeds in constructing a practicable apparatus of this type, he will have a device that will give a representation of sound in an infinite variety of color and pattern.

Such an instrument will afford an extremely interesting and useful piece of apparatus. Its colorful patterns will be found far more delightful than even those of the kaleidoscope.

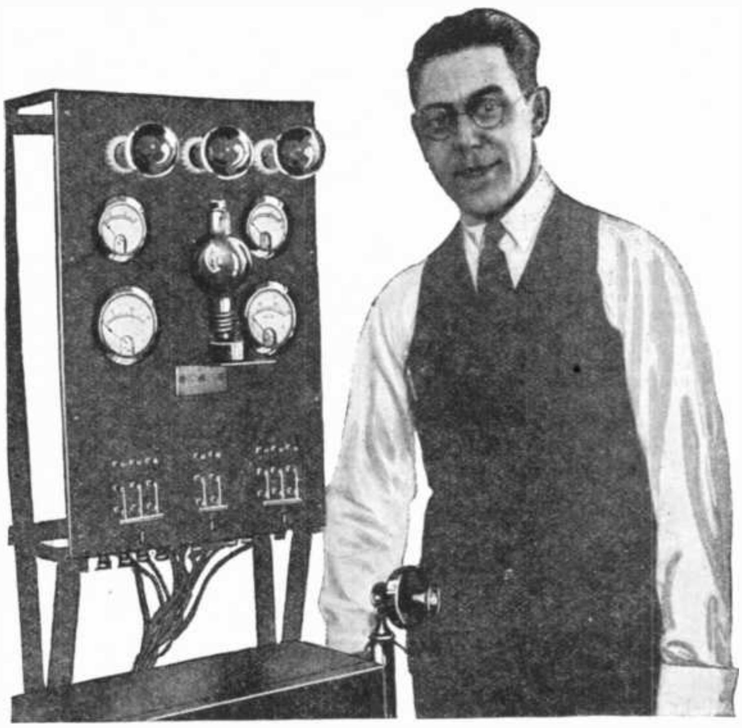
It is questionable, however, whether sufficient current at the output of the push-pull amplifier will be available to light up the incandescent bulbs in the tuned circuits. In this case, small neon tubes may be resorted to. The neon tube usually requires much less than 30 milliamperes to render it luminescent, and so the push-pull amplifier may be entirely eliminated; the three parallel-connected transformers being connected directly to the receiver output. The neon

(*Continued on page 677*)

An Ideal "A" and "B" Battery Charging Panel

By Frank Straub, FS of 2FZ

Honorary Member, Bronx Radio Club



The author and his exceedingly fine charging panel. This panel can be duplicated by anyone willing to spend a few evenings in building it. Sturdy and impressive looking, it is well worth making. Note neatness of symmetrical layout.

HOW many of us would like to have a neat and efficient charging panel for both the "A" and "B" batteries? Surely, such an acquisition would greatly enhance the appearance and add much to the ease of operation in the radio room. The charging panel herewith described is one that fulfills its obligations to best advantage in that it is possible to charge the "A" and "B" batteries one at a time and prevents the accidental blowing out of the tubes by short circuit.

A five-ampere capacity tungar bulb and transformer are mounted on the panel, and by the judicious use of the necessary meters, switches and lamps, we create an appliance that will win its way with all who see it.

On a hard rubber panel, 21" x 14", are mounted three standard 110-volt sockets. These are to accommodate 50-watt lamps which control the charging current when it is desired to recharge the "B" battery. If the latter is of the 100-volt type, it will be necessary to make certain that the battery is so connected that it will be possible to charge two 50-volt sections arranged in parallel. The "B" battery should never be charged at a higher rate than ¼ ampere, as a faster rate of charge is likely to injure the plates. A 0 to 300 milliammeter is connected into the circuit and serves the purpose of recording the rate of charge.

Those not possessing a 5-ampere tungar charger can readily build one by following the outline of the one described in the Radio Oracle department of the March issue of *Science & Invention* or on page 212, March, 1923, issue of *Practical Electrics*. On the other hand, one who has such a charger can convert it into a more serviceable item by following the outline detailed in this article.

A few words about the care and maintenance of storage batteries will not be amiss here and would be very helpful especially to the beginner.

Essentially, storage batteries belong either to the lead-acid or nickle-iron-alkaline type. Of these, the alkaline battery is in many respects the best, but with the proper care accorded to the lead battery, it is possible to use one for a period of many years and experience no trouble whatever.

The most common source of trouble with the lead-acid type of battery is that due to overcharging. When overcharging is allowed, the excessive gassing that the battery undergoes loosens the material on the plates, and thus causes a very marked depreciation in the life of the battery. When this active material is loosened, it generally falls to the bottom of the cell and there forms an excellent short-circuit path for the current.

Again, due to overcharging, the plates are apt to become bent and when the temperature of the cell becomes high, not only may the plates buckle, but the separators may become badly warped so that the efficiency of the battery will fall off considerably.

It is also possible to do harm to the battery by successive undercharging. This allows a condition to exist, wherein the cells run down gradually to a point where one or even two of them become reversed in polarity and thus necessitate individual attention. Undercharging also is a contributing cause for the buckling of the plates.

Careful inspection of the cells or jars should be made periodically. Of course, in most instances, cracked or broken jars can be at once detected by leakage of the electrolyte, or else, when one cell requires water more often than the others. A test with a hydrometer will usually show a more diluted solution than in the other cells.

When corrosion takes place at the terminals of the battery, it is time that they should be thoroughly cleaned. Corrosion takes place due mainly to the action of various causes such as high vapor content in the atmosphere, or the presence of excessive carbon dioxide in a poorly ventilated battery room in which careless handling of the electrolyte results in spilling the solution over the terminals.

As a precaution, the terminals should be greased with plain vaseline. This will effectively prevent corrosion and allow an unhampered flow of current, whereas the corrosion would seriously impede the flow by increasing the resistance.

Insufficient electrolyte such that the top of the plates protrude through, causes sulphation and also enhances the chance for faster evaporation. When adding solution to replenish, be sure that it is not too concentrated, but is diluted to the same degree as the acid in the cell. Generally only distilled water is to be added.

After the battery has been in use some few years, there is apt to be noticed a marked decrease in its capacity for service. In other words, after having received a normal charge, the battery delivers but a relatively small amount of energy and recharging becomes necessary again. The fault may lie in old age or poor material used in the construction of the plates. It is obvious that this condition can be remedied only by replacing the old plates with new ones. It is entirely possible that the plates have been eaten away by a too highly concentrated battery solution. The hydrometer should find greater application and should be treated with consideration and not be used to measure the specific gravity of light or heavy oils, when it was purchased with the sole intention

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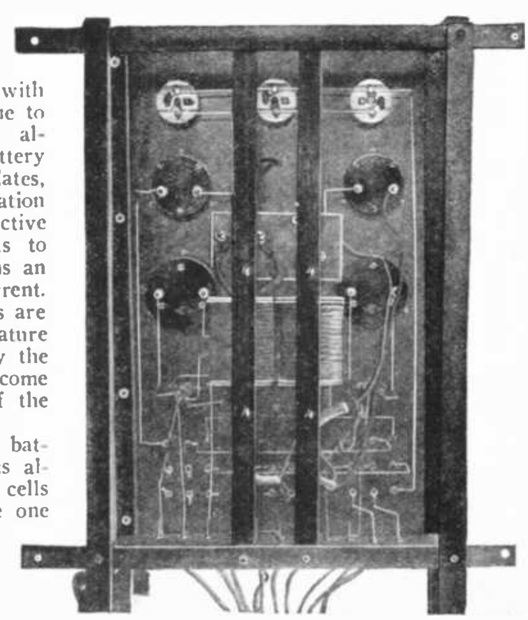
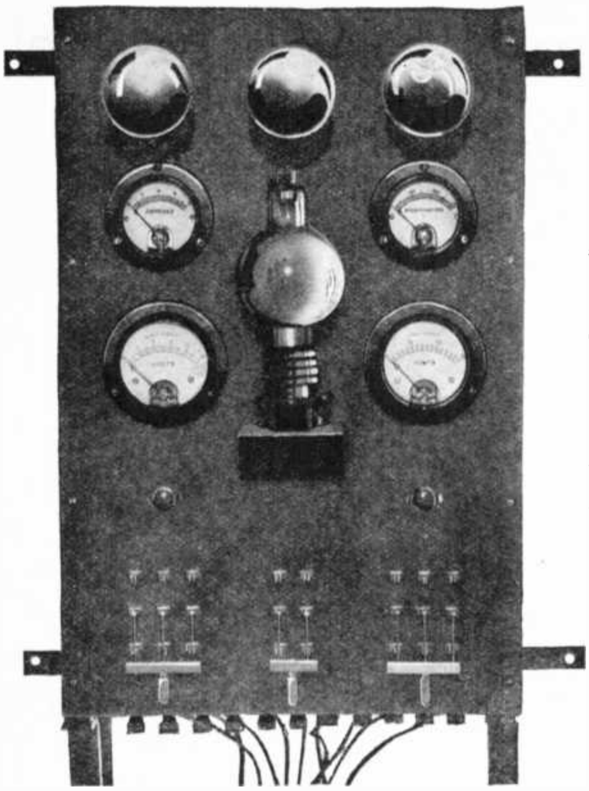
The list of parts and materials necessary for the outfit are as follows:

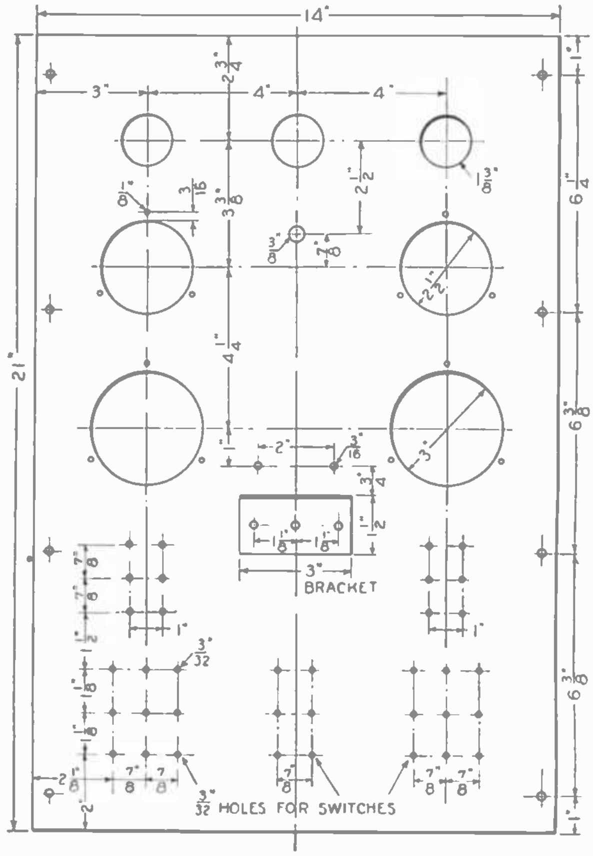
- 1 Hard rubber panel, 21" x 14" x ¼".
- 1 Milliammeter, 0 to 300.
- 1 Ammeter, 0 to 20 D.C.
- 1 Voltmeter, 0 to 10 D.C.
- 1 Voltmeter, 0 to 150 D.C. (Provided with necessary resistance known as multiplier.)
- 2 Small triple pole double throw switches.
- 1 Double pole double throw switch.
- 2 Miniature double pole double throw jack switches.
- 1 Binding post rack.
- 10 Binding posts.
- Steel or wrought iron, 7 feet of 1" x ⅛" stock.



Rear view of the charging panel, showing frame construction and wiring. The wiring terminates in a binding post rack which facilitates connections.



Front of the charger, ready for operation. Miniature switches are used, and the circuits are equipped with the necessary meters to insure harmonious results. As can be seen, the outfit is a beauty in every respect.



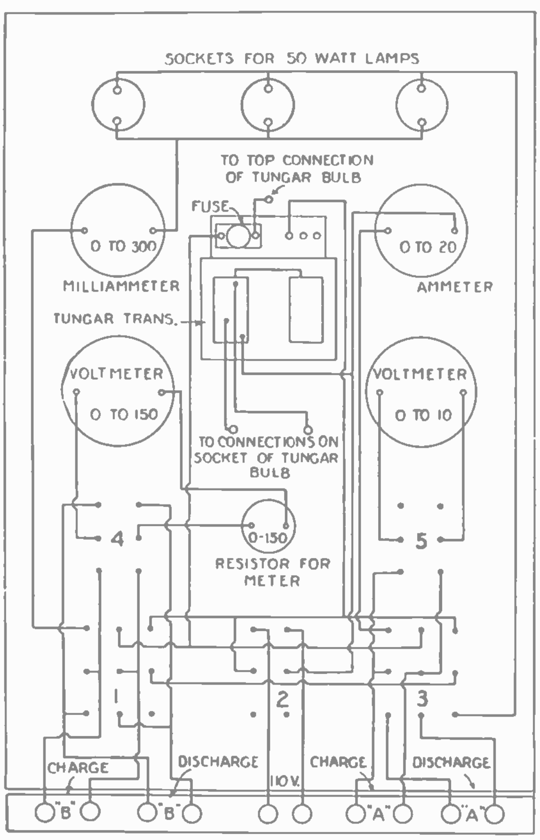
The exact dimensions for the panel layout are given in this diagram. Care should be taken when drilling, so as not to chip or break the panel. Telephone push switches of the DPDT type can be used instead of the ordinary kind.

of using it in conjunction with the batteries.

When the solution in the battery reads 1150, it is time to recharge it. This reading is really the specific gravity reading of 1.15. When fully charged, the reading may be as high as 1.3 or 1300 on the scale. Usually it is between this figure and 1250, depending upon the type of battery.

It often happens that impurities in the solution affect the battery output in no small measure, so that extreme care is advised when refilling the cells. Pure distilled water should be used, or rain water collected after the shower has washed off the roof, will answer. If this procedure is not followed, harmful sulphation is bound to occur and the battery will need complete overhauling. If too much solution has evaporated, add a little amount of pure water, or else recharge at a slightly faster rate at the beginning of the charge, being sure to return to a normal rate. Usually 30 minutes is sufficient, at the start.

So much for the lead-acid type of storage battery. Due to its relatively cheap first cost and low upkeep, it has found much favor in the eyes of the public. However, its main shortcoming lies in the fact that its longevity is not as great as might be desired. Also the fact that it cannot withstand much overload or strain is something to bear in mind when buying a battery.



The nickel-iron-alkaline battery with its excellent mechanical construction together with the stability of the combination of iron oxide, nickel hydrate and alkaline solution is the best type of storage battery. Among the various mistreatments that this type of battery can be subjected to and still remain unaffected, the following ones will indeed be interesting. The battery may be left idle for months at a time, either charged or discharged; excessive and severe vibration will not affect it; undercharge or overcharge and heavy rates of charge or discharge do not affect its life; the plates do not warp or buckle; short circuits or charging in the reverse direction will not hurt it. In a word, it is impregnable to maltreatment—to a large degree.

It can thus be readily seen that great care is not essential in the maintenance and the operation of the alkaline battery.

When fully charged, the voltage is about 1.75 to 1.85 per cell, whereas in the lead-acid battery it is 2 volts per cell.

Complete wiring diagram for the device. It is best to use rubber covered wire, so as to eliminate the possibility of short circuits, although heavy busbar will do. The terminals marked "charge" should be connected to the batteries and those marked "discharge," to the radio set.

The above information will be found quite useful when it comes to deciding questions concerning storage batteries and their respective characteristics.

The battery charger described here will be of utmost value in aiding to prevent accidents in the charging, maintenance and operation of both "A" and "B" storage cells.

Having procured all the necessary materials for the construction of the charging panel, the first step to take is to lay out the hard rubber panel. Refer to the diagram showing its details. Since hard rubber is not difficult to drill, extra precaution is not required, but care should be taken to see that all holes are properly centered. An extension bit in the chuck of a hand brace, or a circle cutter which can be obtained at practically any hardware store, will find good use and help materially in facilitating the work of drilling.

In order that mistakes be avoided, it is best to use a pair of dividers and mark the correct centers and diameters of the holes before drilling. After all the holes have been made, the surface of the panel is rubbed down with fine emery paper and then carefully wiped with a clean rag. A few drops of 3-in-1 oil or linseed oil (not any more since an excess of oil will mean trouble later) are rubbed in thoroughly; the result will be a pleasing, dull gloss which adds to the appearance of the panel.

The iron supporting framework should next be made. Procure at the hardware store 7 feet of wrought iron, 1 inch wide and either 1/8 or 3/16 inch thick. Reference to the diagram will tell the exact lengths in which to cut the material. The framework is tightly bolted together and the assembly, when finally completed, is fastened to the wall.

A small piece of sheet steel whose dimensions are depicted is mounted on the front of the panel and serves the purpose of acting as a support for the 5 ampere tungar bulb.

Having mounted all the instruments on the panel, we now face the task of wiring. This job is perhaps the hardest part of the work, but is relatively easy. No. 14 rubber covered house wire or heavy bus bar is used and affords ample protection against trouble from short circuits and burn-outs.

The three standard sockets are connected in parallel. The 0 to 300 range milliammeter is connected in series with them and serves to tell the charging rate The 0 to 20 ammeter acts in the capacity of recording the rate at which the "A" battery is being charged. The "A" battery should not be charged at a faster rate than 5 amperes, but one will rarely, if ever, find that it will be necessary to keep strict watch, since the tungar bulb may pass no more. The discharge rate, if allowed to exceed 10 amperes for a 100 ampere-hour battery, will shorten the life of the battery greatly. The heat generated within the battery under too rapid charging causes the plates to warp and buckle and results in the active material falling out. One can readily see that careful attention is required and that the life of the battery depends on the treatment accorded it.

The 0 to 10 voltmeter finds a useful function in that it keeps tabs on the voltage of the "A" battery during discharge. This is absolutely essential for the good of the battery as a drop of more than .8 of a volt will mean the rapid deterioration of the battery. In other words, when the voltage reads 5.2 for a 6-volt battery, it is time to recharge. In actual practice, the "A" battery should be recharged once a week, while the "B" battery will need to be recharged once every two weeks.

Remember, overcharging is as harmful as excessive discharging. It is best to watch the meters carefully and place full reliance on them, especially when one cares to spend a few cents more and procure good instruments.

The same applies to the "B" battery voltmeter which is of a range from 0 to 150 volts. The 100-volt unit should be recharged when the reading of the meter is about 85 volts. Of course, it must be remembered that the battery should be arranged in two sections of 50 volts each, connected in parallel A series-parallel switch attached to the battery itself will solve the problem very nicely.

As regards the transformer, it should be securely fastened to the panel with small bolts. The connections to the tungar bulb from the transformer come through the panel. These are made with short lengths of flexible wire, if desired.

The operation of the board is simple. If it is desired to charge the "A" battery, switch No. 2 is thrown in. This connects the 110-volt A.C. supply. Nothing happens until switch No. 3 is thrown in the up position. The A.C. current energizes the transformer and the bulb lights. The ammeter will be seen to record the amount of current flowing through the battery. The reading should be from 5 to 8 amperes.

It may be necessary to reverse the terminal connections to the ammeter, so that it will read in the right direction. Usually an overnight charge will replenish the battery current. If it is desired to use the storage battery, the switch No 3 is thrown down, and by reference made to the wiring diagram it will be seen that the receiving set, or any other apparatus for that matter, is directly connected to it.

When fully charged, the storage battery voltmeter should read 6 volts or slightly more. Switch No. 5 when thrown in the downward position measures the voltage.

For charging the B battery it will be necessary to throw switch No. 1 upward, and for connection to the set, downward. Switch No. 4 connects the voltmeter which determines the condition of the B battery at all times. Only trial readings should be taken and the meters should not be kept in the circuit continuously. This of course applies only to the voltmeters. The ammeter and milliammeter will have to be included in the circuit during the charging of the batteries.

When the wiring has been completed and the circuits have been tested out carefully, the iron framework should be given one or two coats of black enamel. You will be amply repaid for your work and your friends will gaze in wonder at the pleasing assemblage you have created. All that is necessary is careful and attentive work. The outfit described has been in continuous service for the last three years and never once has given cause for trouble. Being mounted against the wall out of the way, it is really an excellent addition to any experimenter's laboratory. How much better is this arrangement than the average charger which is continually "kicking" around the room!

Here are a few good pointers to keep in mind and which when adhered to will greatly assist in prolonging the period of useful service of the batteries.

Charge the battery regularly and sufficiently, avoiding temperatures in excess of 110 degrees F.

Replace evaporated solution with pure water and be sure to add it at the beginning of the charge as otherwise it may not mix properly with the electrolyte.

Do not allow the battery to stand in a discharged condition. Sulphation becomes more difficult to reduce if the battery is neglected. Whereas a discharged battery may freeze, one fully charged is free from that danger in this latitude.

Keep the battery in a clean, dry and well-ventilated place.

Electrolyte which has been spilled should be neutralized with alkali such as soda and wiped up.

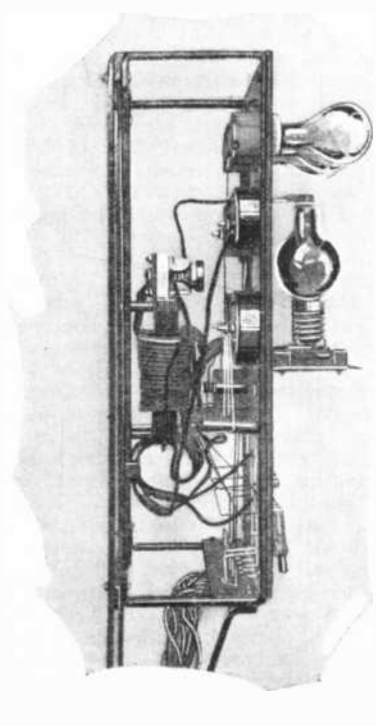
Before going on your vacation, it is best to fully charge the battery and empty all the electrolyte out of it, and wash with distilled water. The separate cells should be thoroughly washed and the battery solution saved for future use by pouring it into non-metallic containers Take out the old separators and replace with new ones.

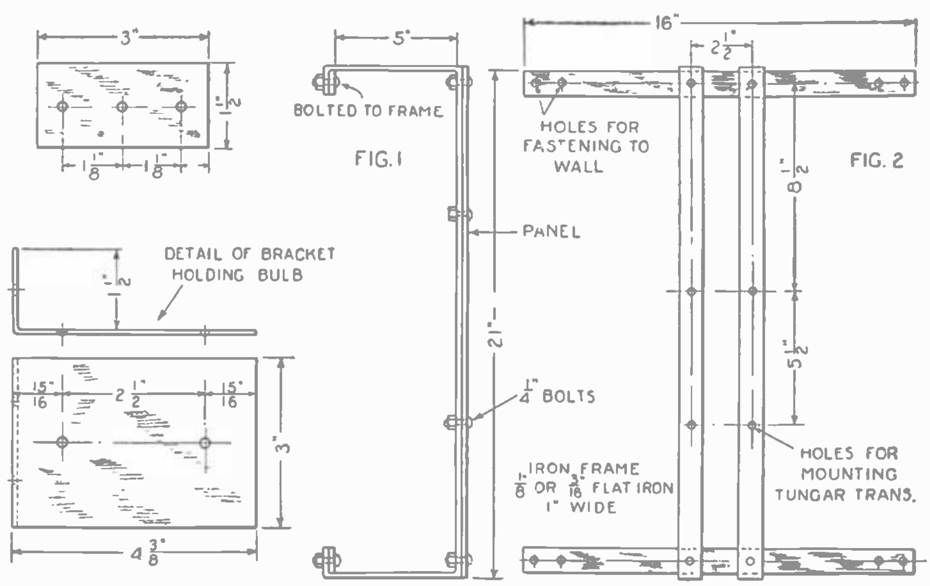
In order to restore the battery to service after a period of disuse, the old wood separators, unless new ones were put in as above, should be carefully removed and replaced by new ones. After the cells have been assembled and filled with electrolyte, they should be allowed to stand a day without charging. The initial charge may require a few days, but need not be continuous.

With average careful use, the Tungar bulb will last several years and give perfect satisfaction.

If so desired, two 6-volt storage batteries can be charged in parallel. If two or more 22½-volt "B" battery units are desired to be charged simultaneously, it may be necessary to employ 100-watt lamps instead of the 75-watt ones.

Those who have a complete charging outfit and would like to enhance its value and increase its utility will have something they will be very proud of if they build the outfit described in this article. A copper screen enclosing the framework will further add to the beauty of the charger and aid in keeping out extraneous matter and prying fingers.



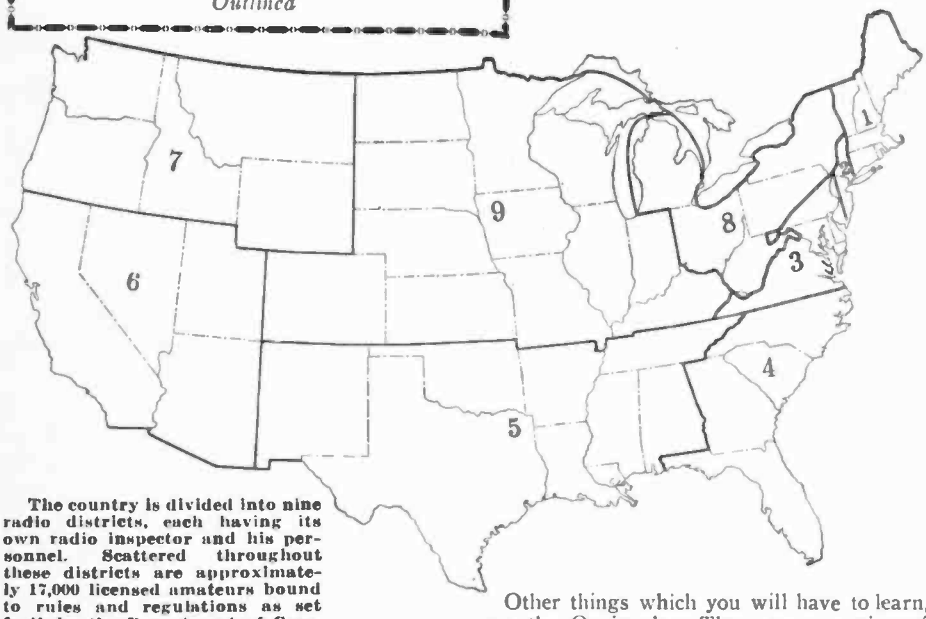


Left: Side view, showing how the transformer is mounted on the iron frame. Note accessibility of the various parts and instruments. Above can be seen details for the construction of the iron framework which is made in two parts. Fig. 1 represents the front and Fig. 2 the back of the supporting members which can either be bolted or riveted together.

Getting On the Air

By A. P. Peck, 3MO Assoc. I.R.E.

The Ethics of Amateur Transmission and the Correct Operation of a Station Briefly Outlined



The country is divided into nine radio districts, each having its own radio inspector and his personnel. Scattered throughout these districts are approximately 17,000 licensed amateurs bound to rules and regulations as set forth by the Department of Commerce, Bureau of Navigation.

AFTER having learned to properly transmit and receive the International Morse code, after a license has been obtained, and your station is in operation, you find yourself up against another problem, *viz.*, following the correct and accepted forms of transmission between amateur stations. The backbone of the amateur organization depends entirely upon intercommunication between stations. In this way new friendships are formed and many pleasant hours are passed just "chewing the rag." It is this that binds the amateurs of the country together in a fraternal organization. To join this organization you need pay no dues, nor attend meetings nor do any of the other things that are usually connected in the mind with clubs and societies. Of course, you can join your local radio club, and it is advisable to do so as you will undoubtedly obtain great benefit therefrom. However, the other organization that we mention is merely the fellowship of communication. Through the medium of your transmitter you will get in touch with many other persons throughout the country who have tastes similar to yours. In the paragraphs below we will outline the various forms used for transmission and also present some of the courtesies which must be extended to other operators

If you intend to go in for the handling of traffic, as the interchange of relayed messages is called, you must establish the usual form of handling messages. When a message starts from your station, it should be assigned a number; that series of numbers to run for one year, whereupon you will start again with number one. This number is incorporated in the message and the entire form is as follows:

"2CYW u 3MO. Nr 1. To John Doe, 1111Main St., Dunellen, New Jersey." Then follows the body of the message and the signature.

The period between the transmitting station's call and the Nr 1 is called the break and is sent — ... —, not .. .. .. as is the usual period. This break signal is often used throughout the message, and you will soon become used to employing it.

Other things which you will have to learn, are the Q signals. These are a series of internationally used abbreviations which tend greatly to speed up communication. Use them whenever you can. We give below a list of the most common ones, together with their meanings. When you send a certain signal and follow it with a question mark, the meaning is that given. If no question mark is used, the signal stands for a similar statement.

QRA.	What is your location?
QRH.	What is your wave-length?
QRK.	How do you receive me?
QRM.	Are you being interfered with?
QRN.	Is static strong?
QRQ.	Shall I send faster?
QRS.	Shall I send slower?
QRT.	Shall I stop sending?
QRU.	Have you anything for me?
QRZ.	Are my signals weak?
QSA.	Are my signals strong?
QSB.	Is my tone bad?
QSL.	Did you receive my acknowledgment?
QSR.	Will you forward a message?
QST.	Have you received the general call?

Aside from these conventional signals there are others that have been adopted by amateurs for their own use. Those which should be well known are listed below.

CQ. I desire to communicate with someone.

73.	Best regards.
88.	Love and kisses.
CUL.	Call or see you later.
OM.	Old man.
YL.	Young lady.
OW.	Old woman.
NIL.	Nothing.
Hr.	Here.
Etc.,	etc.

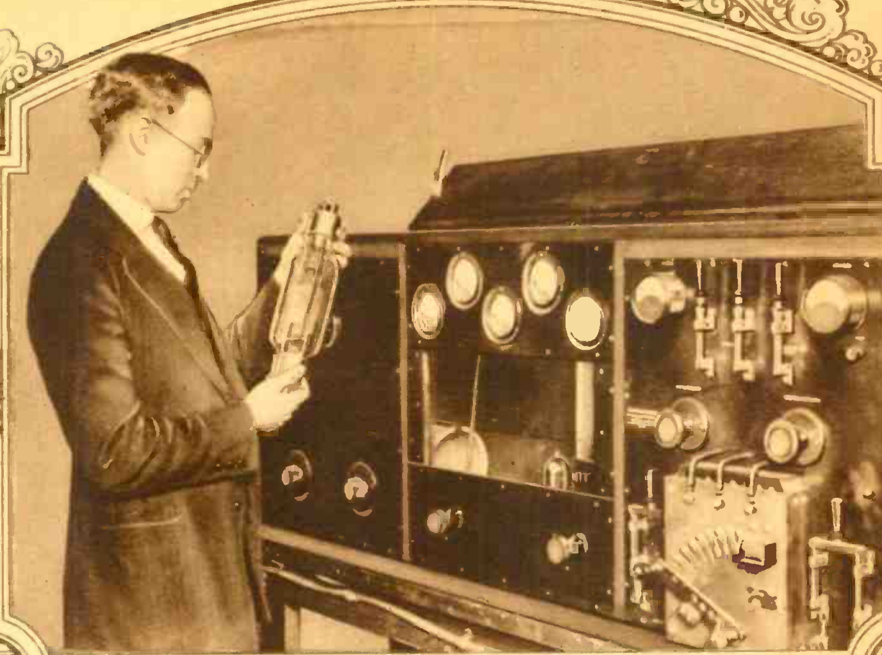
These are the ones that are most generally used, and in addition, simplified or phonetic spelling is introduced into transmission. When you are sending, make every effort to cut down the length of messages, so that no unnecessary time will be consumed in putting over your idea or message to the other station. You will make a bad reputation for yourself unless you do this, and you will seldom find anyone willing to communicate with you. The radio bore is just as bad as the social misfit who earns that title. Be sure that you do not become one.

Let us suppose now that you have memorized the above listed Q signals and are ready to actually start your transmission. You should make it known among your neighbors and friends that you will try to relay messages to any part of the world for them free of charge. Undoubtedly, some neighbor of yours will have a message that he would like to have transmitted to some distant point. Let us say that this message is going West from your station. Listen in on and near the wave-length to which your transmitter is tuned and see if you hear anybody calling CQ in the general direction in which you want your message to go. If you do not, call CQ yourself, following each signal with the word West. You will soon raise someone who will answer you. The conventional and advisable way to call CQ in this case is as follows: CQ West, CQ West, CQ West u 3MO, 3MO, 3MO. Repeat this three times and then listen in for at least two minutes. When listening, start at the top of the band on which you are working and slowly rotate your tuning dial to the lower end of the band. If you do not hear anyone answering you, reverse the tuning again to the top of the band. Then you can call again as above. If after the third try you do not raise anybody, let that message stand for an hour or two and try again. Undoubtedly in the meantime you will hear someone calling CQ, who will take the message off your hands and relay it further on its journey. If possible, of course, try to place the message with some station in the town for which it is destined. The receiver will then immediately telephone or mail the message to the party to whom it is routed. You are to do the same in the case of messages received by you for your town. If you get a message to relay to some point a little further on, and you cannot relay it within a reasonable length of time, 24 hours at the outside, mail it immediately to its destination. In this way, traffic is kept on the move and never tied up at one point.

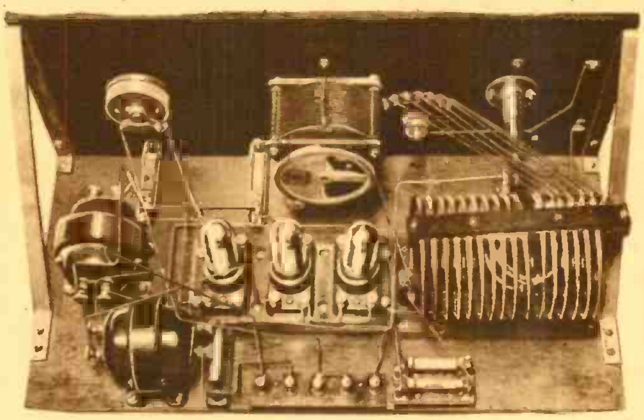
Above all, during your entire transmission time, do not cause local QRM. This can be done in many ways such as tuning your transmitter during hours when extensive transmission is being carried on, or testing during the same period of time. Avoid causing any interference of this nature. Another thing you must remember is never to send an interminably long CQ. Often you will hear an operator start up and send that conventional signal steadily for five or ten minutes at a time, never once pausing to sign. This type of operator seldomly if ever gets any answer, and he often thinks that his transmitter does not work properly. In reality, the fault is all his own. If he would give a short, snappy CQ and a slow sign, he would undoubtedly raise someone. It would be a good idea for anyone transmitting to do a little missionary work here. If you hear of an operator committing the above-mentioned sin, stand by until he finally signs off. Then call him and tell him that he is "jamming" things and ask him to try to give a better and shorter call the next time. Most amateurs and beginners when their attention is called in this way will heed and do better the next time. Before you do this, however, be sure that your own conscience is

(*Continued on page 673*)

Radio Developments



Religious organizations are not to be forced off the ether by powerful jazz stations. The photograph at the right shows a highly efficient installation operated by a well-known church in New York City. The engineer is holding one of the new type of 250-watt transmitting tubes. It is interesting to note the rapid strides being made in the development of better broadcasting. It is a sign of permanent usefulness of radio that such institutions as churches and colleges have adopted it as a means of communication with a more extensive audience than their auditoriums will hold.



A remarkable low loss short wave receiving set, by Mr. Kenneth Hewitt, 2RK, famous pioneer in amateur radio communication. It is provided with three UV-199 tubes in a regenerative detector and two-step amplifier. The set has picked up signals from every corner of the earth. Especial note should be taken of the tuning inductance which is wound with quarter-inch tubing and is supported in but two places by means of thin bakelite strips. The primary inductance is tapped at every turn, while the secondary is tuned by a vernier condenser. To eliminate influence by hand capacity the tickler coil is provided with a long shaft. The shortest possible connections are used and resistance is thus kept at a minimum. With but one tuning control, the set is ideal for amateur radio code reception covering a wave-length range of 75 to 200 meters.

Although one of the first to employ CW transmission, the builder of the set shown above, Mr. Kenneth Hewitt, 2RK, has undoubtedly been the last to relinquish the spark and its time-honored supremacy as an ether racket raiser. He is shown at right affectionately fondling a few relics which have seen their day: a synchronous rotary spark gap and a pancake coil type oscillation transformer. At one time the slogan used to be "a mile per watt" and lucky was he who could cover 1,000 miles with a 1 kw. outfit. Today, several thousand miles with a 5-watt tube is merely good work.

Ark of the Covenant

By Victor MacClure

[What Has Gone Before]

A number of New York banks have been robbed. The time is near the end of this century. The President of one of the banks stands by his son's bedside early in the morning and tells him of strange robberies. They fly to New York in an airplane.

They find that throughout the financial district everyone has fallen senseless. Automobile engines have mysteriously stopped. Everything of gold, watches, coins, gold leaf signs and the like have been tarnished. The vaults of a number of banks have been cut open, apparently by oxyacetylene, and robbed.

Powdered glass is found in the street to add to the strange events. Little lead cases came into the Post Office by mail. Raduim salts were enclosed in them.

The airplane Merlin, the fastest of all airplanes, takes an active part in the story. The mystery deepens when it is found that some millions of dollars of securities have been returned to the banks, but a slightly larger amount of gold has been taken. Anaesthetic bombs are thought of. A provision store has been robbed and money left to pay for what was taken. Thousands of gallons of gasoline have disappeared from a Standard Oil Station.

They go out on the famous Merlin in search of the liner Parnassic after having vainly tried to find how the gasoline was taken from the station; they hear that there was a cabin in the air when the robbery was being perpetrated. Going out to sea, they land upon the Parnassic. Everyone on her is recovering from a trance, and eventually the Captain goes with them to the treasure safe and finds that it has been robbed.

Lord Almeric, a well preserved man of 60, joins them. The crew recovers. A discussion ensues and it is concluded that the raiders used an airplane. The Merlin starts off after the ship's engines begin to turn, taking with them the charming Miss Torrance, the niece of Lord Almeric, who is also of the party. As the Parnassic reaches port, investigations into her robbery are in order.

Now news comes that Louisville has been attacked, and an hour and forty minutes takes the Merlin to Louisville, where the New York raid has been duplicated. Next the Atlantic is crossed to Europe where similar raids have been perpetrated.

The robbery of the Bank of England is investigated. Mysteriously, only a relatively small amount of gold was taken. Gasoline has been taken from the English tanks. The House of Commons was subjected to the soporific agent and when they recovered members on the Treasury bench found their faces blackened with burnt cork. Paris and Berlin are raided on the same day. Radium left by the raiders is still a mystery.

A search for the mysterious airship or raider begins in earnest. The Merlin leaving police machines far behind, shortly after the take-off from England reaches American and Gardiners Bay without sight of the enemy. And now our hero wants a roving commission for a new Merlin, for the first one has several successors, to carry out his own and his associates' views as to the raider. He proposes to arm his airplane and go off prepared for attacking and for defense. An appointment with the President of the United States is made and the Merlin goes to the federal capital. The interview with the President follows, a very cordial one as young Boon's father is a friend of Mr. Whitcomb, the President. Meanwhile it seems that Miss Torrance has been pleading the cause of the Merlin at the White House and all goes smoothly.

In spite of delay due to carburetor trouble the search is prosecuted and at last the enemy is sighted. Eager to attack, a gas defense by the enemy threatens. The gas begins its work upon the Merlin's crew.

The Merlin is gassed by the raider. An airplane is launched from an English cruiser to join the attack. Signal flags transmit messages back and forth between the cruiser and the Ark of the Covenant. Then comes a description of the landing of the Merlin on the deck of the English cruiser, and the Ark of the Covenant meanwhile has disappeared at amazing speed and the Merlin, after her fight with the airship, has a rest. In England there is a business panic, the Government falls. The Merlin and her crew at last return to America. Information comes directly from the raider that she desires to stop all war.

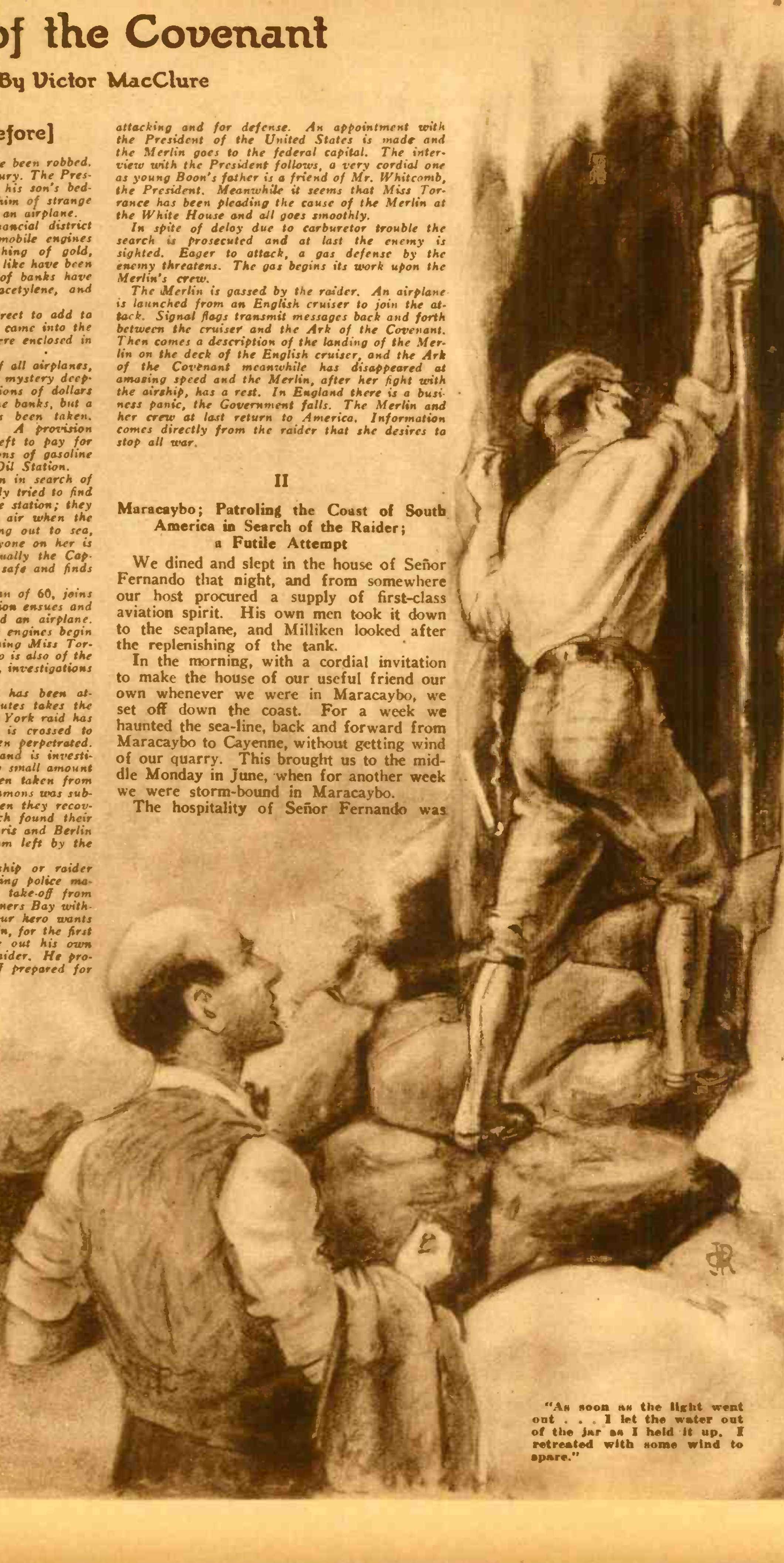
II

Maracaybo; Patroling the Coast of South America in Search of the Raider; a Futile Attempt

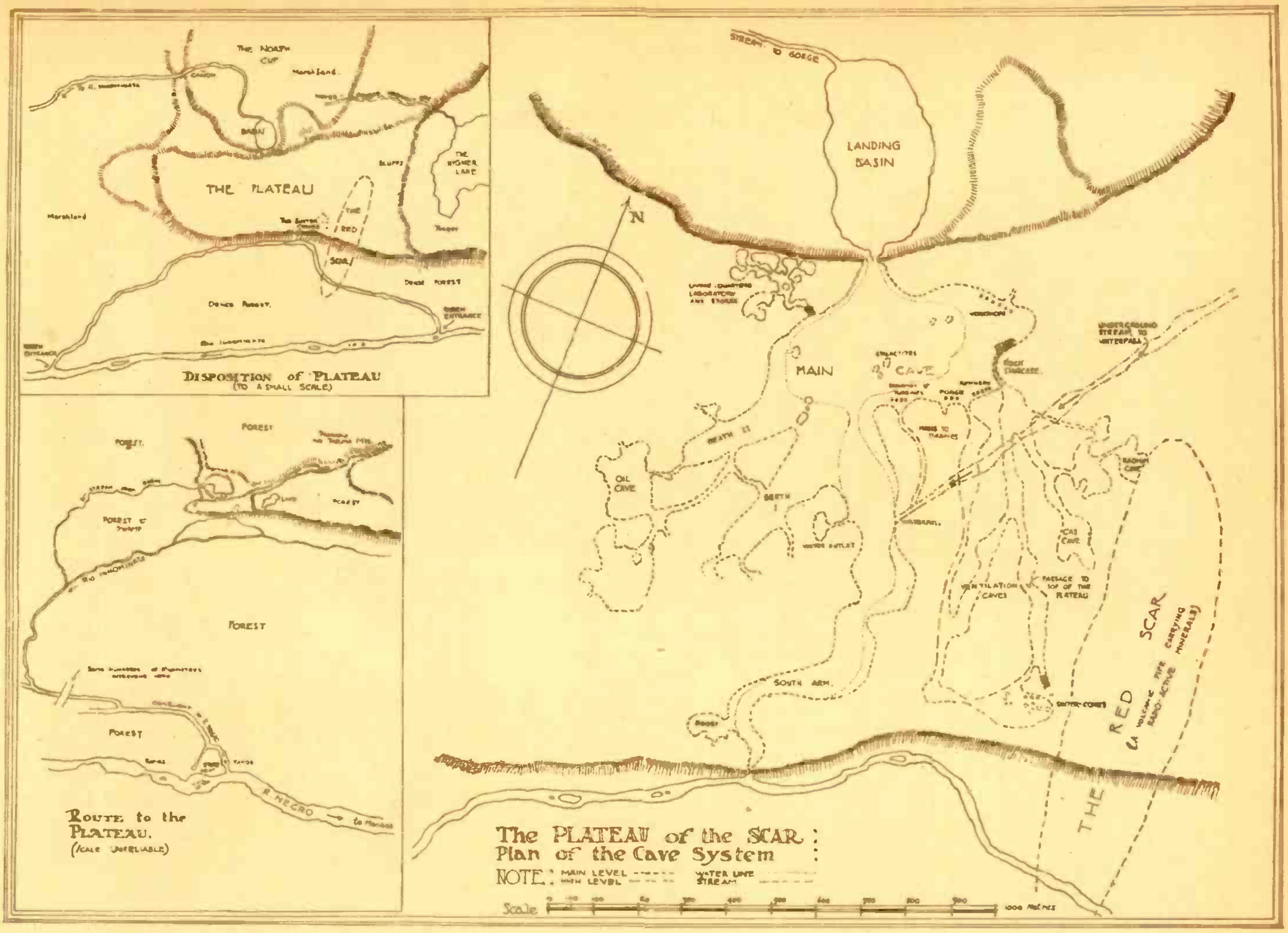
We dined and slept in the house of Señor Fernando that night, and from somewhere our host procured a supply of first-class aviation spirit. His own men took it down to the seaplane, and Milliken looked after the replenishing of the tank.

In the morning, with a cordial invitation to make the house of our useful friend our own whenever we were in Maracaybo, we set off down the coast. For a week we haunted the sea-line, back and forward from Maracaybo to Cayenne, without getting wind of our quarry. This brought us to the middle Monday in June, when for another week we were storm-bound in Maracaybo.

The hospitality of Señor Fernando was



"As soon as the light went out . . . I let the water out of the jar as I held it up. I retreated with some wind to spare."



"From the map it will be seen that both the Innominata and the stream from the basin in the northward cup flow west for the greater part of their courses."

limitless, but our enforced inactivity was very galling. Our only consolation was that if we could not take the air, neither could the raiders. But by the Saturday of the third week in June the tropical storm was over, and again we set off down the coast of the Main. We trailed along the Leewards, and on the Sunday morning early got out from Port of Spain to search the Lesser Antilles, for we were still keen on Milliken's idea.

Then at eleven o'clock that Sunday we picked up a radio telling of an airship raid on shipping on the other side of Panama. We made right back to Maracaybo, where we found Señor Fernando, to whom we had radioed, waiting for us in the harbor with a full supply of gasoline. We filled up, and were off again.

We came down at Panama to seek information, and we were told that the raids had taken place on the New Zealand route off the Galapagos. These islands were our next objective, and we made them just on nightfall. We were mighty tired, though by this time Dan was up to handling the machine and had been spelling Milliken and me, but as we could find no safe mooring, we took off again and reached Guayaquil in the dark. Here we found a mooring in the roadway of the bay, and we hitched to it without asking permission. We set no watch, but lay down to sleep, determined to be stirring with the first streak of daylight. But when daylight came, we landed on a piece of bad luck.

It was just after four in the morning, and Milliken and I were going over the engine. A sudden imprecation from my mechanic made me go over to the side he was examining, and I saw him gazing with a rueful face at the gasoline supply pipe to one of the starboard carburetors. It was snapped clean through close to the carburetor.

"Well," I said, "there's no use making a post-mortem on the thing, Milliken. We'd better straighten one of the coils a bit and braze a new junction."

"Right, sir," said Milliken, and went to his locker for the necessary tools.

Although we had flown from Maracaybo to Panama, and from there to Galapagos, thence to Guayaquil, I was not prepared to see the gasoline gauges so low. I concluded that there must have been a good deal of leakage from the fracture, before it absolutely parted, and I took one of the dago boatmen that were now round the plane, and went ashore for a supply of the juice.

My boatman was a traveled man and a linguist, and I was able to make him understand what I wanted. He conducted me up the quay and led the way to a gasoline store sure enough, but it was somewhere round half-past four in the morning, and there was nobody about. The place was shut.

I was standing grumbling at the luck, when suddenly my dago let out a yell, and began pointing right above him into the sky.

"See, señor!" he cried. "Look, look! The airsheep!"

The Ark of the Covenant, the Raiding Airship, is Seen But the Merlin is Crippled at the Very Time Her Services Are Required Most

A thrill ran up my spine, for there—high above the town—like a tiny spear blade of silver in the growing light of the morning, floated the *Ark of the Covenant!* I was sure of her. There were no two ships of the same design in the world—unless they belonged to the raiders.

It was galling, I need hardly say. There lay the *Merlin* in the roadway with a parted gasoline pipe, crippled to a certain extent, and with her tanks more than half empty! And high above her the quarry sped, serene and beautiful, heading straight across the Andes!

Mad as I was, I had the sense to take an accurate bearing of the airship's course, then I flung myself into a useless activity. I yelled at my dago, and at the others who were gathering round. I threw money at them, and made them hustle to find the man who ran the gasoline station. As good luck would have it, he turned out to be a Scotsman, but it was forty-five minutes before he made his appearance, for he lived outside the town. When he did come, he came running, and he was still putting on his clothes as he came.

In as few words as possible I explained the situation to him.

"Bide a wee," he said, unflustered. "Let's think. I could give ye petrol frae tins in the store, but ye'd have to manhandle it to your plane—and that'd take time. No, by jingo I have a tanker lying at the quayside bung fu' o' the juice. Could ye maneuver your boatie alongside? We'll soon have your tanks fu' if ye can."

Give me a Scotsman any day for sense! I hustled McQuharrie into the boat and we pulled out to the *Merlin*. Milliken had the breakage fixed, and we taxied the bus alongside the tanker. In no time, McQuharrie had a pipe and a pump fixed between the tanker and the plane, and in a little the *Merlin's* tanks were brimming.

"How much is that, Mr. McQuharrie?"

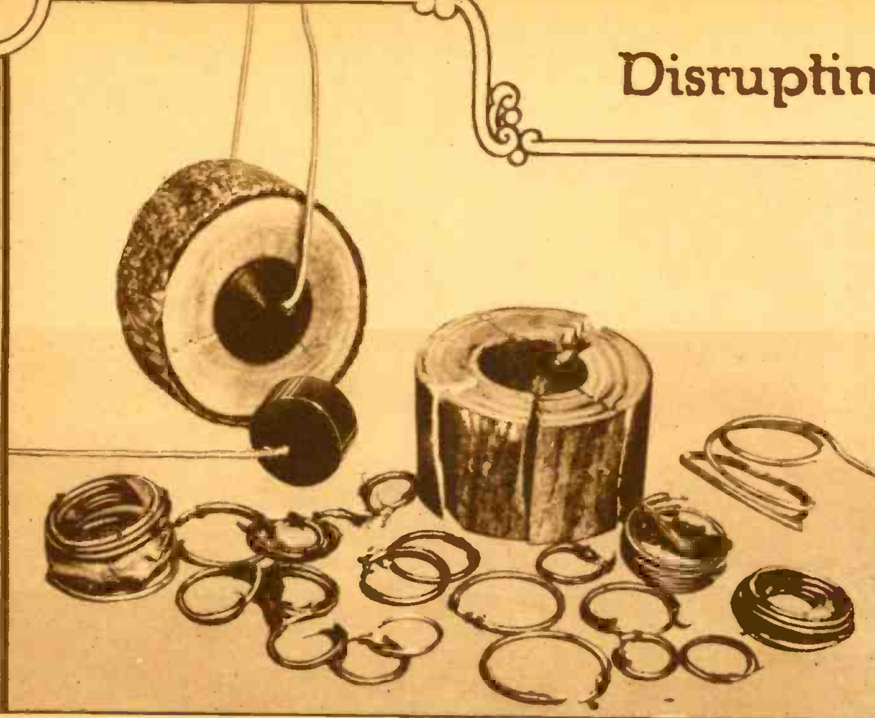
"Damned if I know—I didna measure," he replied. "Don't bother wi't. Off you go, man! I'll send ye a bill——"

(*Continued on page* 703)

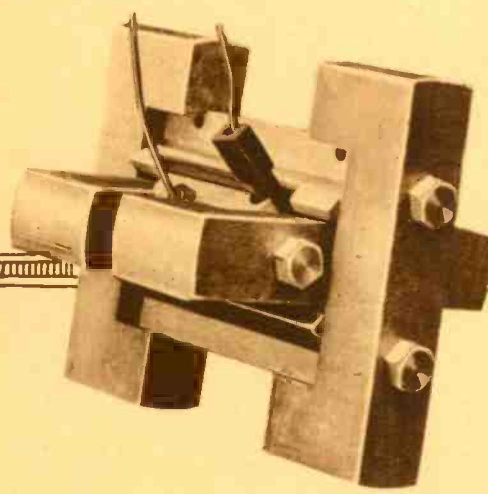
Disrupting the Atom with

By Prof. T.

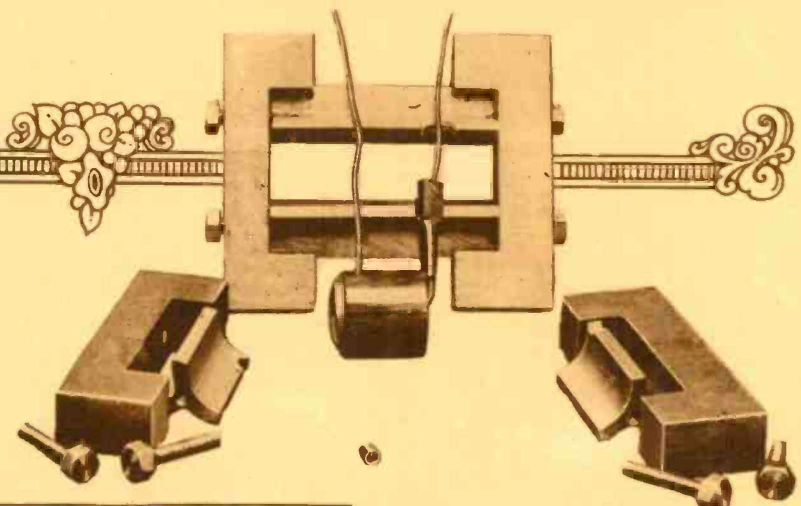
Professor T. F. Wall of the University of Sheffield, England, who, in the course of experiments with magnetic fields of tremendous intensity is claimed to have succeeded in disintegrating the atom.



Pressures of several tons due to the magnetic fields are active in the small coil used by Professor Wall in his experiments. The illustration above shows this coil before and after an experiment. Not only did the magnetic force tear the coil apart but it cracked a strong shield of wood (lignum vitae.)



The force exerted by the magnetic field of the small coil used by Professor T. F. Wall was so great that it was necessary to construct this powerful steel frame to keep the coil intact.



The component parts of the steel shield constructed to withstand the great mechanical stresses due to the very intense magnetic fields developed in a small coil when a transient current of about 40,000 amperes is sent through it.

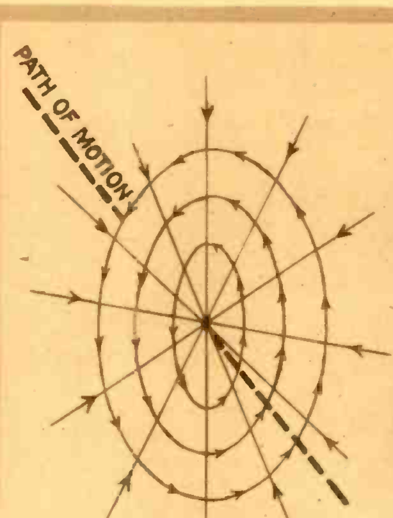
A view of the equipment used by Professor Wall in his experiments with very intense magnetic fields. The coil used in the experiment is immersed in oil contained in the tank seen on top of the desk.

Intense Magnetic Fields

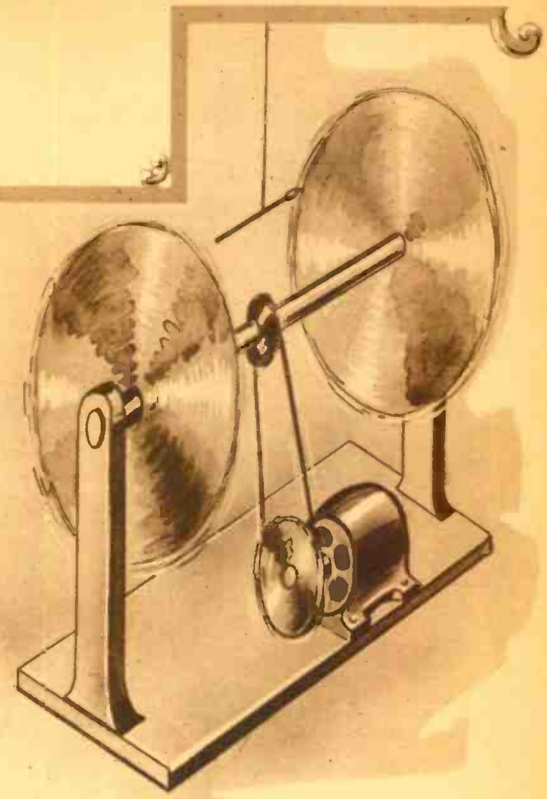
F. Wall

THERE is good reason to believe that the use of very intense magnetic fields may prove to be one of the most powerful means yet devised for attacking the structure of the atom, as well as for producing profound modifications in the magnetic properties of materials. It is also expected that the knowledge obtained as a result of such experiments may lead to the placing of the theory and practice of magnetism on a more complete scientific basis whereby, for example, it may be possible to predict what change in the magnetic properties of a steel may result from a given change in the ingredients.

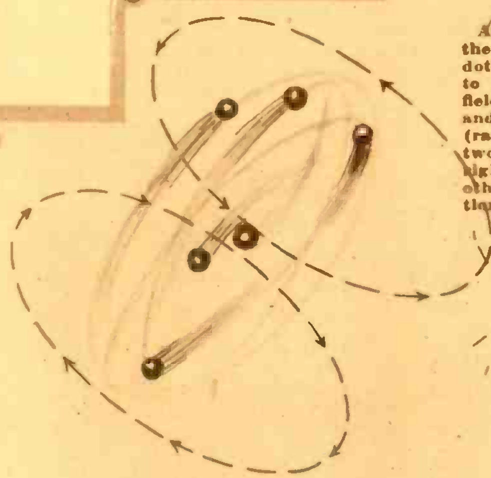
The application of this class of magnetic fields as a means of attacking the structure of the atom is a matter of the greatest fascination from a scientific point of view; it is also of vital importance from the point of view of national welfare. In fact, it has been suggested that the world's rapidly disappearing stores of available energy may eventually be replenished by the use of released atomic energy.

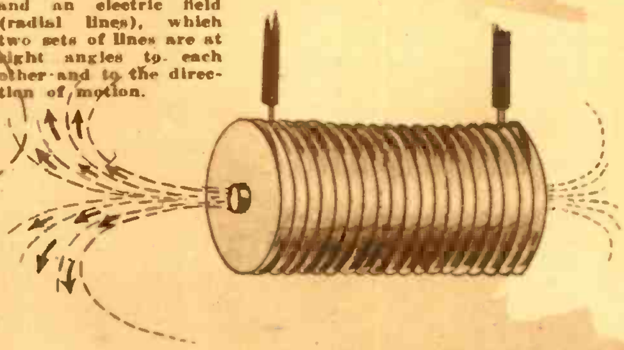


An electron moving in the direction of the dotted line is supposed to set up a magnetic field (circular lines) and an electric field (radial lines), which two sets of lines are at right angles to each other and to the direction of motion.

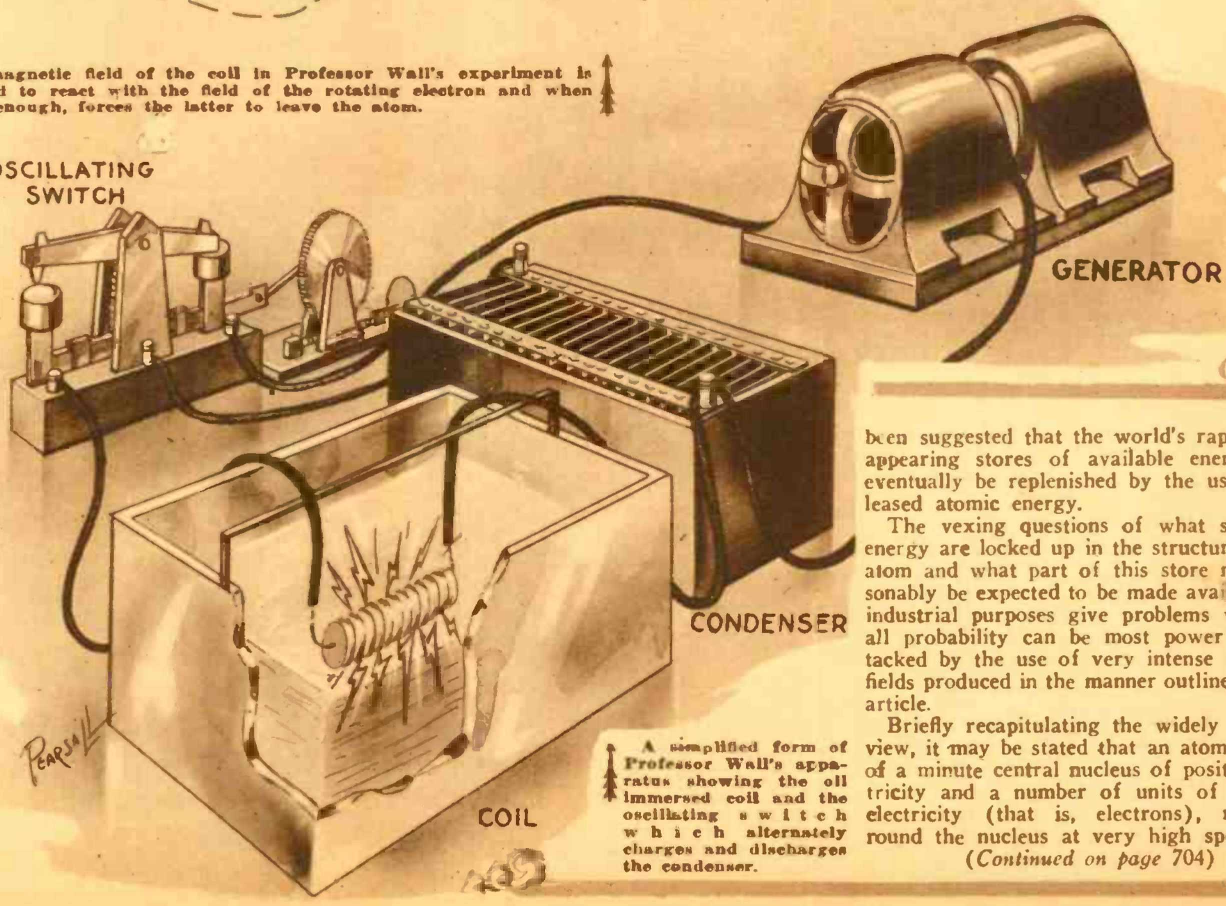


To demonstrate that the electric current is an electric charge in motion Rowland charged two discs and by revolving them at a very high speed caused the deflection of a magnetic needle suspended between them.





The magnetic field of the coil in Professor Wall's experiment is supposed to react with the field of the rotating electron and when strong enough, forces the latter to leave the atom.



A simplified form of Professor Wall's apparatus showing the oil immersed coil and the oscillating switch which alternately charges and discharges the condenser.

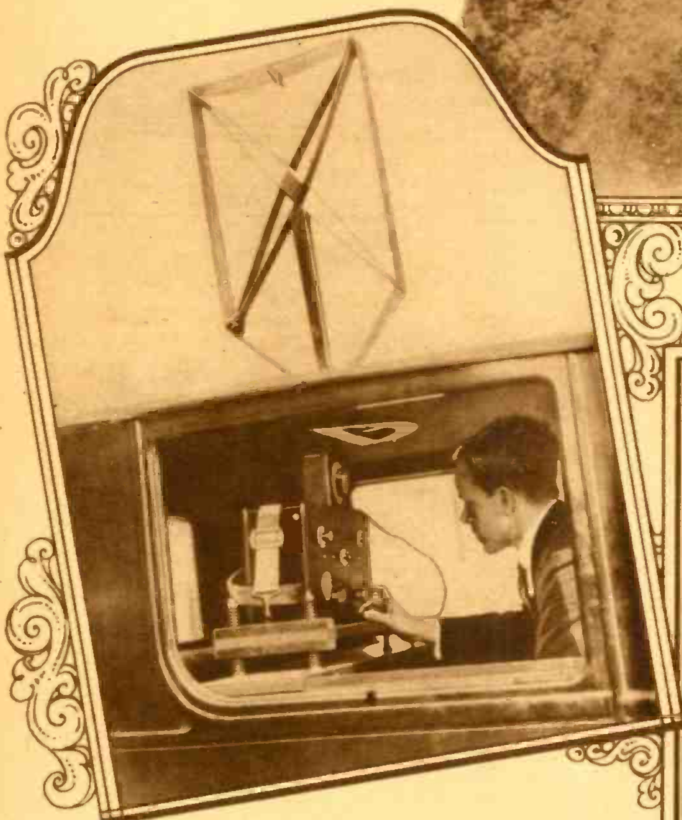
The vexing questions of what stores of energy are locked up in the structure of the atom and what part of this store may reasonably be expected to be made available for industrial purposes give problems which in all probability can be most powerfully attacked by the use of very intense magnetic fields produced in the manner outlined in this article.

Briefly recapitulating the widely accepted view, it may be stated that an atom consists of a minute central nucleus of positive electricity and a number of units of negative electricity (that is, electrons), revolving round the nucleus at very high speeds and

(*Continued on page* 704)

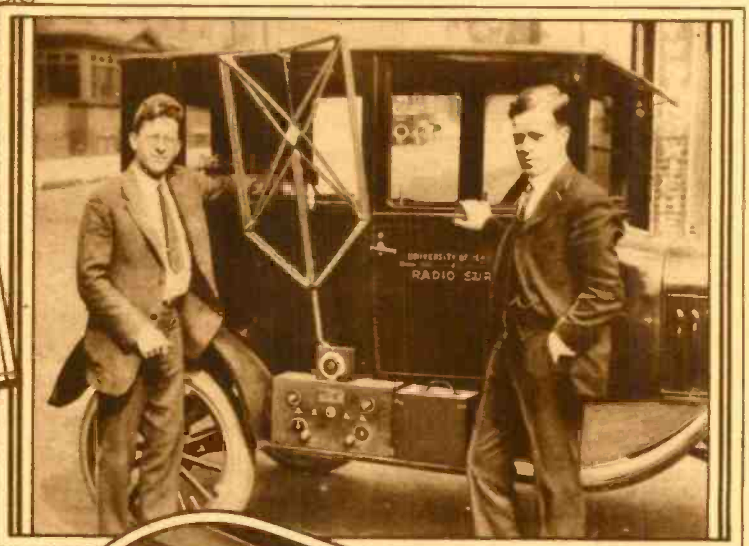
What Experimenters Are Doing Today

The greatest experimenter of our time is shown at right reading the inscription upon the tablet erected at Menlo Park, N. J., as a permanent memorial of his work.

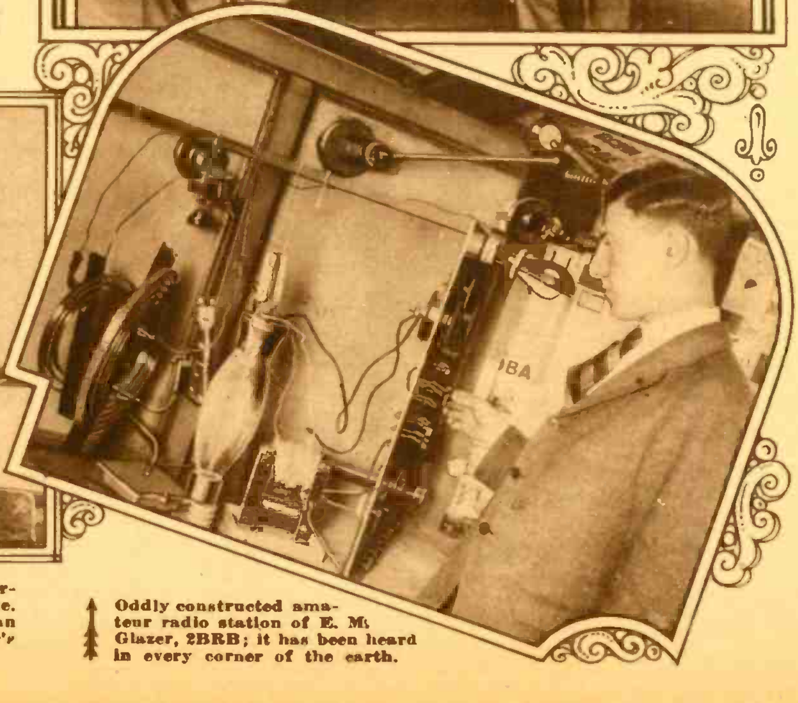


The University of Pennsylvania radio survey car showing the mounting of the specially designed super-heterodyne set. The loop aerial is mounted on top of the car.

Three members of the Moore School of Electrical Engineering, University of Pennsylvania, are planning to make a study of radio waves from this especially equipped radio survey car. The car is provided with a super-heterodyne set.



Students of New York University preparing for a radio debate. The microphone is connected to an amplifier by which the speaker's radio voice may be judged.



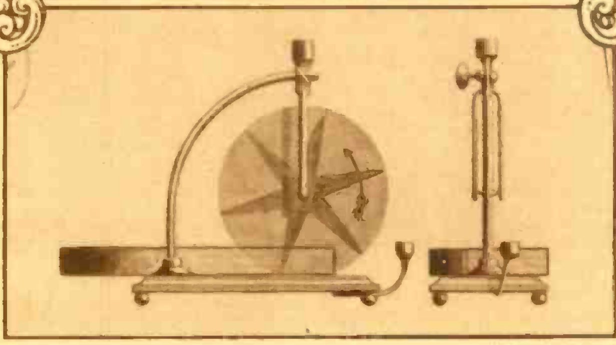
Oddly constructed amateur radio station of E. M. Glazer, 2BRB; it has been heard in every corner of the earth.

Historical Experiments

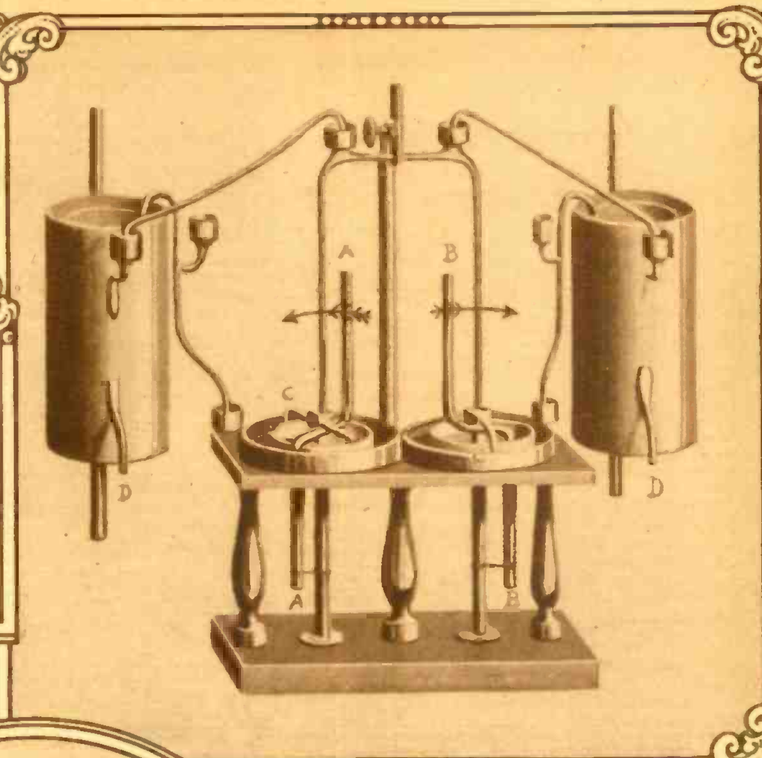
Number 9

Early Electric Motors of 1825

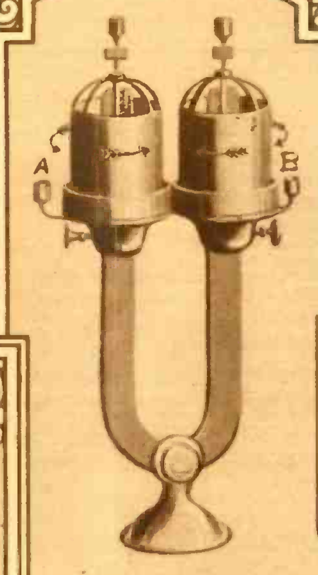
Designed by William Sturgeon



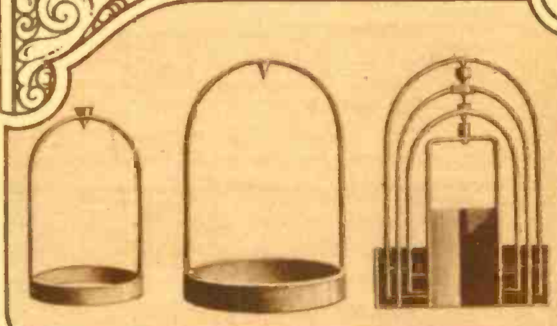
A form of Barlow's wheel familiar to readers of THE EXPERIMENTER. Current flowing from the center of the disc to the mercury well with which its periphery makes contact reacts with the field of the magnet and causes rotation of the disc.



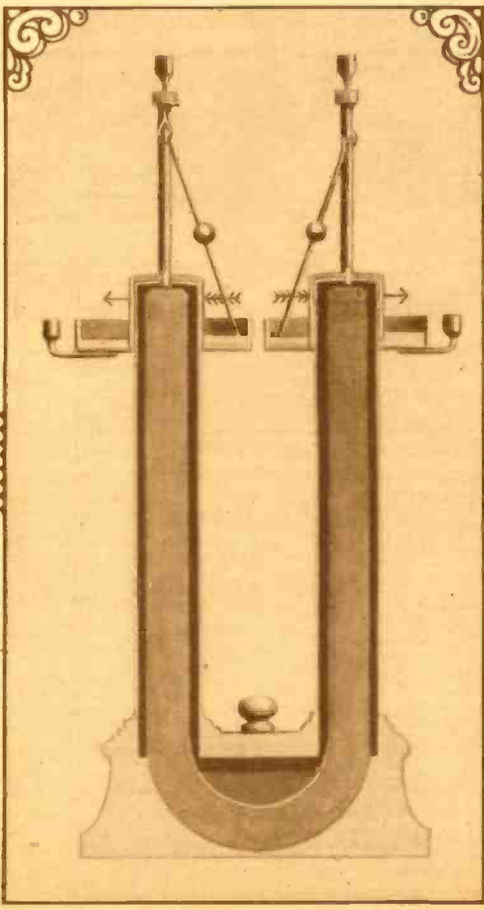
Currents flowing down the vertical wires and returning to the batteries DD, through the mercury contact arm, C, react with the pivoted bar magnets, AA, and, BB, causing the latter to rotate.



The lower periphery of the metal cylinders, A and B, is immersed in mercury connected to one terminal of a battery, the other terminal of which connects to the tops of the cylinders. The current flows parallel to the axis of the cylinders and causes rotation by its reaction with the field of the horseshoe magnet on which the cylinder is mounted.

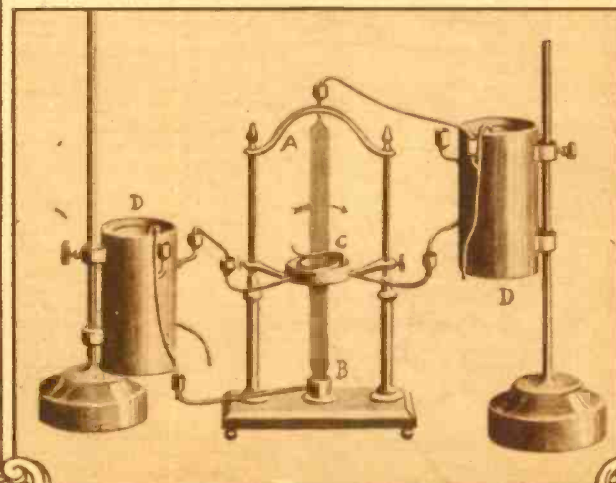


In this motor, a trough containing dilute acid is mounted on the pole of a magnet. The inner and outer cylinders are made of zinc and copper respectively and rotate in opposite directions. Between them is a support rigidly attached to the trough.



This is a modified form of an apparatus devised by Faraday and published in the December, 1924 issue of THE EXPERIMENTER. Current flows from the upper end to the lower end of the wire which dips into mercury. The unlike poles of the horseshoe magnets cause the wires to rotate in opposite directions.

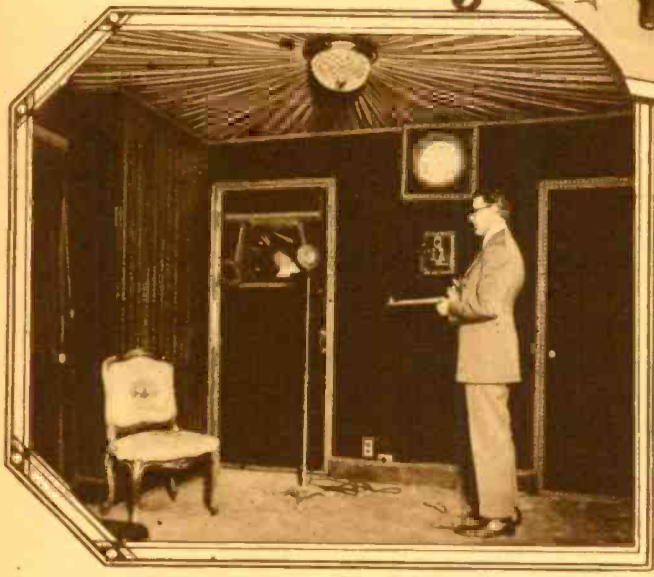
In this ingenious apparatus a bar magnet, AB, is made to rotate about its own axis. Two like terminals of the batteries, DD, are connected to the mercury trough with which the arm, C, makes contact. The other terminals are connected to mercury cup, A and B.



Station WRNY
258.5 Meters

Owned and operated by the publishers of THE EXPERIMENTER. The editors of the magazine deliver lectures from this station on Monday, 9:00 P. M., Thursday, 9:30 and 10:00 P. M., and Friday, 9:45 P. M., of each week.

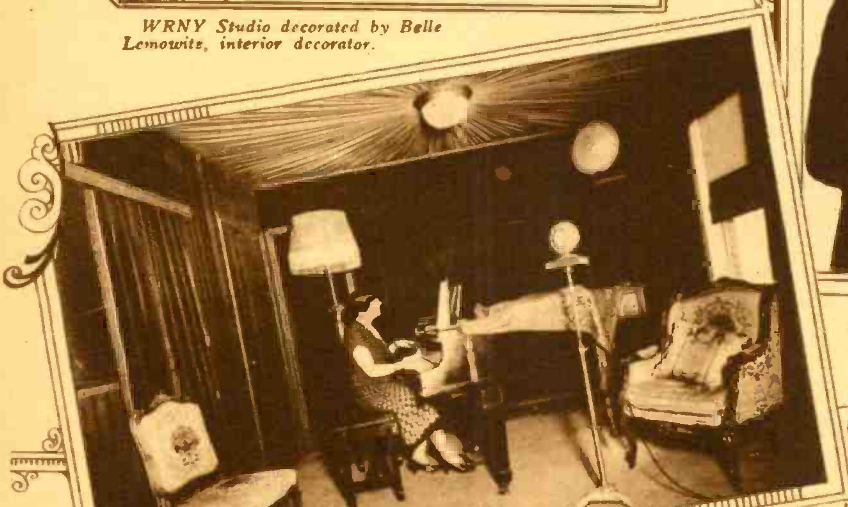
The RADIO NEWS ORCHESTRA, conducted by Mr. Joseph H. Kraus.



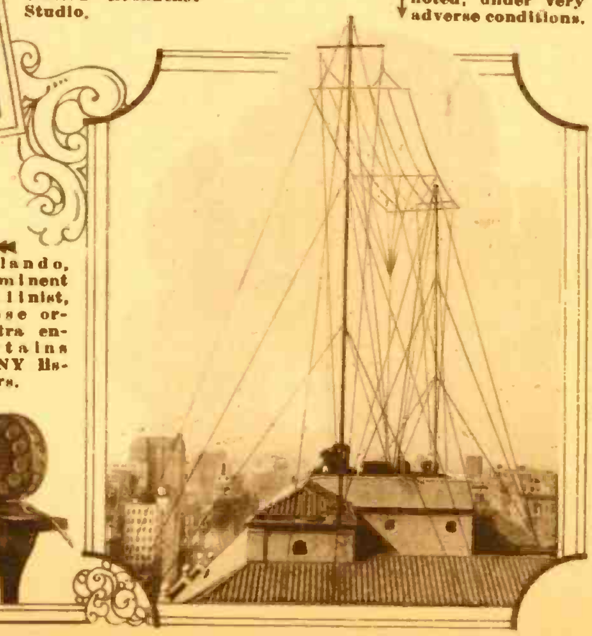
Mr. Willets, chief engineer of the station, announcing. Control room is seen through the door window.

WRNY Studio decorated by Belle Lemowitz, interior decorator.

Mr. Hugo Gernsback taking effective measures to cut "Bugs" Baer, famous humorist, off the ether at a late hour.



A view of the WRNY Broadcast Studio.



WRNY aerial erected, as will be noted, under very adverse conditions.

Ruth Kemper, well known violinist, appearing at WRNY.

Orlando, prominent violinist, whose orchestra entertains WRNY listeners.

Getting On the Air

(Continued from page 664)

clear. Do not try to call down the other operator for sins which you frequently commit yourself.

Another thing that seems to have diminished the interest in the amateur game of late is the lack of co-operation between stations in the relaying of messages. It seems that lately most of the stations want to call some "DX" (distance) station, raise him, ask him to QSL and then sign off. Such stations seem to care not a bit for relaying messages or for chewing the rag. Such work does not seem to help the game at all unless you are undertaking special test work, wherein it is desired to see just how far some certain transmitting circuit is capable of working. However, probably not one in a thousand amateur stations are doing important work of this nature, and therefore there should be more actual communication between stations. The sentence "OK OM pse QSL uv QSA hr cul 73" is heard all too often. Avoid it if possible. Furthermore, never fail to QSR a message when requested to. You can gain a good reputation for yourself by always relaying immediately quicker than any other way.

Another thing that you never should do is to call some station when you hear it communicating with some third party. Never break in on a call. Suppose you should hear a certain ninth district station calling a station in the eighth district? Even though you may have some traffic going in the direction of that ninth district station, do not call him until you hear him sign off finally with the other station. To call him would probably be a waste of time because CW transmitting stations emit such a sharp wave that the ninth district station would probably never hear you anyway, being tuned to another wave. After he signs off at the conclusion of his conversation with the other station, he will probably go searching through the ether for someone else with whom to communicate. Then and only then is the time for you to call him. Start your call immediately after he signs off.

When you send out a CQ yourself, and start tuning for an answer, let us suppose that you immediately raise someone. Note the location on your dials at which his station comes in and continue in your tuning so as to cover the entire band. Then if

In early days when "old man Jones" used to be terribly upset whenever he heard a racket in the phones, little did he suspect that the noise might have been static, ship interference, or the terrible quality of the modulated music as it was "hashed" out.

two or more stations answer you, answer all of them, telling all to stand by while you work one. This is the courteous way to handle a situation of this nature. If you only listen to one of the stations and do not bother to find out if anyone else is calling you, the station that you do not hear may have something important for you that you will then miss.

A few years ago, when broadcasting was first placed on a commercial basis and broadcast receiving sets were in their embryonic stage, considerable friction ensued between the transmitting amateur and the broadcast listener or BCL. At this time the BCL's were of the opinion that all other things must stop in order to allow them to go on with their reception. Tuners were so non-selective that it was impossible for them to separate the broadcast stations from the amateur transmitting stations, and considerable QRM was caused by the amateurs through no fault of their own. Even today there are occasional cases of interference between BCL's and amateurs. In such cases, however, with the knowledge which amateurs have of radio today, and with all the information which is available on the subject, it is easy to dispose of the trouble.

Therefore, after you start transmitting and have been on the air one or two nights, make inquiries among your BCL neighbors as to whether or not they have been experiencing any interference from your transmitter. If they have, you should proceed to trace the cause of the interference to its sourcle and eliminate it. Below we will outline the causes of interference and tell how they can be overcome.

Articles Wanted

We want good electrical, chemical and radio articles, and here is your chance to make some easy money. We will pay from one to two cents a word upon publication for all accepted articles. If you have performed any novel experiment, if you see anything new electrical, if you know of some new chemical or radio stunt, be sure to let us hear from you. Articles with good photographs are particularly desirable. Write legibly, in ink, and on one side of the paper only.—EDITOR.

Probably the greatest reason why some BCL's have trouble with interference is because of the fact that they are usnig conductively coupled tuners of some type or other. Under this head comes the old single circuit tuner, the two variometer type, and variable condenser type and a few others which have been given odd and fancy names. Practically any type of receiver which is conductively coupled with the antenna and ground is not selective. Furthermore, what is known as key-clicks from the transmitting station affect this type of receiver and cause noises to be heard in the phones or loud speaker connected to the broadcast receiver. These clicks are caused by the sudden starting and stopping of oscillations in the transmitting vacuum tube circuit. They will come through and register on a conductively coupled receiver, but if you can get a BCL who is trouble in this way to change his set to an inductively coupled type, he will usually find that trouble from this source will disappear. However, some methods of keying transmitter circuits are such that they cause bad key-clicks which cannot be eliminated even by the use of inductive coupling in the receiving circuit. The worst offender in this line is the transmitting set, which employs the method of keying in series with the grid return to filament. If you will look over the article of this series, which dealt with the construction of a transmitter power supply, you will note that the key is shown inserted in series with the plate transformer or where only one transformer is used, in series with the positive high tension lead. Either one of these two methods produce the least amount of key-clicks that it is possible to have. The one using the plate transformer is by far the best. If you are using any other method of keying than these two and have trouble with your neighbors, due to key-clicks, try these methods of keying and you will undoubtedly eliminate the trouble. It is to your own interest that you do this, and that you bend all your efforts towards the removal of interference with the BCL's. If trouble continues between these two factions, there is a possibility that the same thing may happen to all of us that is illustrated in the upper right-hand corner of this page. Let us hope not, however, and let us all pull together and work for the good of all those interested in radio, both BCL and amateur.

Poor Willie!—and the amateur is proud to say that there have been very, very few like him. Only when there is outright violation of the laws governing radio communication, does the government ever find need to bring restraint upon the erring amateur.

All that there is to the successful operation of a station besides remembering the certain conventional signals and other short cuts is the exercising of a little common sense. Extend the same courtesies to your unseen friends of the ether that you would to someone whom you are entertaining in your own home. If you do this, you will be sure that your signals will always be welcome in every station, and if you develop a good "fist," you will have no trouble in communicating with any part of the country that you desire and which your transmitter will cover. The term good "fist" relates to the way in which the transmitting operator forms the various characters. A slow, even method of transmission is to be far preferred to a fast, irregular "fist." And so I will leave my readers here with this, the last article of this series. In the future I hope to be able to present further constructional articles on various phases of amateur apparatus. CUL, es 73.

There is no one thing in the life of a radio amateur that is more conductive toward his progress in radio than the joining of a radio club. Meet one or two of your local amateurs and find out about the club that they belong to. Make arrangements to join this club immediately.

A Word About Condensers

By Sidney E. Finkelstein, A.M.I.R.E.

A VARIABLE condenser consists essentially of two sets of parallel plates, made of a conducting material, separated by an insulating material, the latter called the dielectric, with some means of varying the relative position and consequently the facing areas of the surfaces of the conducting plates. Among the materials that may be used for the plates are aluminum, brass, white metal, or the surface of a well of mercury. The thin sheets of tin foil or copper foil used in fixed condensers are too fragile to be used in any variable condensers of ordinary design.

By far, the most efficient material for the dielectric is air, although mica is used in some variable condensers for the sake of compactness. The importance of an efficient dielectric may be understood from a study of the electrical action of a condenser. An electric current, direct or alternating

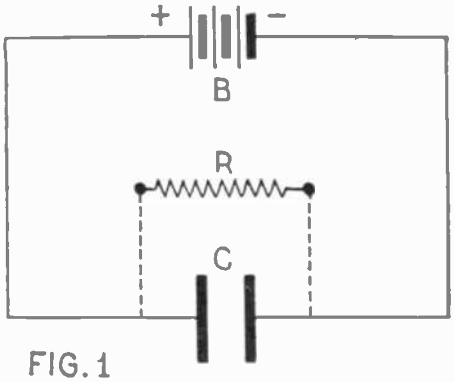


FIG. 1

If we insert a condenser in series with a low voltage source of direct current, the effect is the same as introducing an infinitely high resistance which acts as an almost perfect insulator and allows no current to pass.

(or "oscillating," as the radio engineers say) does not really flow through a condenser—it cannot, for a wall of insulation blocks its path. Instead, when a voltage is applied, current flows from one side of the circuit into one set of plates, and tries to flow into the dielectric. The energy in this current produces a charge of static electricity in the dielectric, and the electric pressure of this charge stops any more current from flowing. If one volt, for instance, is applied to the condenser, current will flow into one set of plates until the air between the plates has been strained to a tension of one volt, stopping any more flow of current; and all the energy that flowed into the condenser is stored up in the air between and around the plates. Whenever the one volt of outside pressure is taken off, the energy flows out of the condenser again, the same as from a charged storage battery, but with this big difference: A storage battery may be charged and discharged once a week. But when a signal of 200 meters wave-length enters the tuning condenser of your radio set, the tiny voltage of the signal charges the dielectric of the condenser, then dies down and lets the condenser discharge into the receiving circuit, and then charges it in the opposite direction, all at the rate of 1,500,000 times a second!

Each one of these times the entire signal which trickles down the antenna is stored in the space between the plates. The ideal condenser having no losses would consist of nothing but plates and space. This condenser would put back into the circuit, at each oscillation, all the electrical energy put into it, while in less perfect dielectric materials—mica, waxed paper, etc.,—part of each charge is absorbed and lost. Every little loss means weaker signals and broader tuning.

In old-fashioned condensers with big flat ends of insulating material, lying close to the plates, the losses were high. These ends come within range of the electrostatic field around the plates and act like two very inefficient rotor plates, soaking up part of the strength of every signal. The latest designs of low-loss condensers use as small an amount of insulation as possible, and place it out at the edges of the plates, away from the electrostatic field which covers the surface of the plates.

With this latter type of construction, the end frames of the condenser are made of metal, and carry the bearings for the rotor shaft. These end pieces then become, electrically, a part of the rotor circuit, acting like two extra metal plates. When the rotor is connected to the grounded side of the circuit, these end plates shield the condenser from the capacity of your body when your hand touches the dial. But here we run into another trouble; these end plates cannot be tuned "out" like the others. When the dial is turned to zero, there is still left some capacity between these metal ends and the stator plates. The way to cut out this undesirable capacity is to make the end frames in skeleton form—an open frame or spider—and to space them some distance away from the stator plates. A "grounded end-plate" condenser will always show a high minimum capacity unless the ends are open, and spaced away from the plates.

The best design of condenser is the one that includes these features and still gives the instrument a strong, rigid frame to hold the plates accurately in line. Cast ends are generally more rigid than stampings.

The use of rigid metal ends gives the manufacturer a chance to use good-sized brass or bronze bearings. A piece of machinery lasts no longer than its bearings; good bearings mean long service.

Dielectric	*Inductivity Value, "K"*
Air, at ordinary pressure, standard	1.00000
Manila paper	1.50
Celluloid	1.555
Paraffin	1.68–2.32
Beeswax	1.86
Paraffin wax	1.9936–2.32
Paraffined paper	3.65
Resin	1.77–2.55
Petroleum	2.03–2.42
Hard rubber ebonite	2.05–3.15
Turpentine	2.15–2.43
India rubber, pure	2.22–2.497
Sulphur	2.24–3.84
Gutta percha	2.46–4.20
Shellac	2.74–3.60
Olive oil	3.00–3.16
Sperm oil	3.02–3.09
Glass, common, AF	3.25–4.00
Glass, common, RF	4.21
Mica	4.00–8.00
Porcelain	4.38
Quartz	4.50
Castor oil	4.80
Flint glass, very light	6.57
Flint glass, light	6.85
Flint glass, very dense	7.40
Flint glass, double extra dense	10.10

Fig. 3. Table giving dielectric value constants of the more familiar insulating materials.

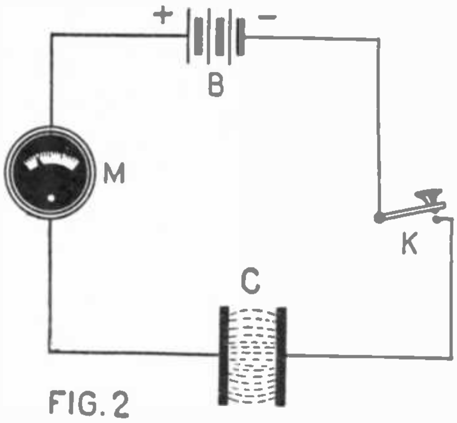


FIG. 2

A sensitive meter included in the circuit will show a momentary deflection when the circuit is opened or closed by the key K. At the same instant, electrostatic lines are set up between the plates of the condenser C.

Considerable friction has to be introduced into the bearings of most designs of condensers to make the rotor stay as put. The plates of the rotor, being all on one side of the shaft, would descend of their own weight, which they do when the friction is minimized. This can be overcome by fastening a large counter-weight on the shaft, or better yet, by splitting up the rotor plates into two counter-balancing groups on opposite sides of the shaft. The stator plates are then split into two corresponding groups, and by insulating these groups from each other, we gain a big advantage. We now have two or more separate condensers working on the same shaft which can be combined in series or parallel to give a wide range of capacities, or can be used to tune separate circuits with one dial.

Getting the current through the bearings and into the rotor is another problem. To avoid the scratchy noises that come from variations in contact at the bearings, the common practice is to use a "pig-tail" or flexible connecting wire, and then put a stop-pin on the rotor to keep the wire from being twisted off. This gives a good connection, but if the "pig-tail" is broken by the slipping of a screw-driver or by long use, in come the noises again. Rubbing spring contacts are more permanent and substantial, and when several parallel spring contact-fingers are used together in multiple, the contact is perfect.

There are other losses to be guarded against, besides those previously mentioned—the resistance which the radio frequency currents have to overcome in getting out upon the plates of the rotor or stator and back again, so many thousand times a second. These currents travel mostly on the surface of any conductor; so that aluminum, which keeps its bright surface reasonably well, is a very efficient material for the plates. Brass is often used so that the plates can be soldered to their supports.

The radio frequency currents do not penetrate into the metal, but travel over the surface of the metal under the oxide film which may be on its surface. Resistance due to oxide can be decreased by nickel-plating, preventing oxidation, as is done with the other brass parts on the condenser; the resistance of nickel is one-third that of lead solder or of the lead alloys used to die-cast condenser plates. A practical and very efficient way to support both rotor and stator plates is to mill a set of slots in brass blocks, force the plates into them under pressure, and then rivet the brass into the surface of the plates. This milled comb and riveted plate construction is ideal for aluminum plates; the hard brass of the comb cuts into the aluminum and makes a solid electrical joint.

These milled combs have now pretty generally replaced the old style spacing washers on both rotor and stator of the better class of condensers, but all condensers do not use the best means of securing electrical contact. Milled combs give absolutely accurate spacing, and make the whole instrument more rigid and trouble-proof. Rigidity is essential, for the distance from stator plate to rotor plate is only, on the average condenser, twenty-seven thousandths of an inch. Imagine the plates left out of the condenser you are buying, and judge whether the framework that is left is sufficiently solid and self-supporting. A common test is to turn the plates all "in," hold the condenser by the front end frame, and watch the plates when you press down on the shaft. You should not be able to notice any movement of them.

A good deal of study has been given to means of getting a fine vernier adjustment for the capacity of a variable condenser. Experimenters have found that the single vernier plate becomes loose and wobbly with use, and it is difficult to make good electrical contact to it. There are now on the market several good designs of spur-gear or friction-geared vernier movements, which move the whole set of rotor plates very gradually as the vernier knob is turned. For this purpose, spur-gears are a little more positive, but friction gearing is smoother acting. This type of vernier has a big advantage over the old vernier plate, in that a station always comes in at exactly the same point on the dial, whether the vernier is in our out. In judging verniers, the one with the simplest and fewest moving parts is apt to give the longest service.

In addition to following all these principles of design, a condenser must be built with the precision of a scientific instrument. This means accurately fitted parts, and a nice looking careful finish on each part. Of course, an attractive finish may not make the condenser work any better, but it is generally a good indication of the amount of care and thought put into the instrument.

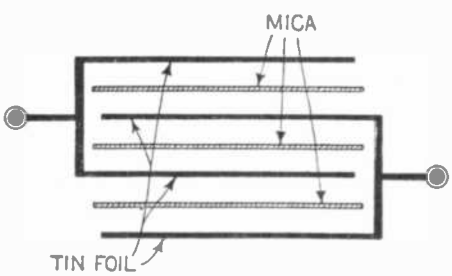


FIG.4

Method showing how an ordinary grid or phone condenser may be assembled. Applied pressure increases the capacity.

The best judge of these points is the user, and the best test is the test of service.

When the experimenter is confronted with a new circuit he will in many cases be instructed to use in a certain part of a circuit a condenser of perhaps .0005 mfd. capacity. It may also be stated that a condenser of this figure (or of some other as stated) is the only thing that will produce the desired results. Just what does this figure mean? What is it that all condensers have that make it necessary that the correct one is used, if a particular diagram is to be followed out?

If a battery as in Fig. 1 is connected to two metal plates which are separated by a non-conducting material or insulator, the arrangement of plates and insulator is called a condenser. The insulating material is called the dielectric.

The term condenser is very misleading. This electrical apparatus does not condense anything. It is just a storehouse for electricity. As it receives or stores a greater or less amount of electricity, its voltage rises or falls. Its capacity is stated in farads or in fractions or multiples thereof; a farad is the capacity of a condenser, which will have one volt potential, when charged with one coulomb of electricity.

If we have a perfect insulator, a steady current cannot flow through it. If a source of voltage such as a battery, as in Fig. 1, is applied between two points of an insulator, a momentary flow of current will take place when the source of voltage is connected, but this current will very quickly cease. This current flow is very different from the flow of current through a copper wire or any other conductor.

Fig. 2 is the same as Fig. 1 except that a very sensitive indicator of electric current as a galvanometer is inserted in the circuit as indicated by "M." If the circuit is closed at "K", a sudden deflection of this indicating device will occur. This deflection very soon returns to zero. This deflection or momentary flow of current is due to a sort of electric strain or displacement of electricity. This strain is resisted by a reaction or bucking effect of the condenser and the electric strain or current flow is stopped. Thus as in Fig. 2, when the steady voltage of the battery "B" is applied to the condenser, the electric strain reaches a steady value and the current flow will become zero. If the voltage of the battery is allowed subsequently to diminish, a current flow will be had in the opposite direction. A current of this kind will exist only when the electric strain is changing. Direct current cannot produce a change in electric strain, therefore direct current cannot go through a condenser. Alternating current only can create such an electric strain.

It has now been determined that an alternating current applied to two metal plates separated by an insulating material will produce an electric strain due to varying charges. The amount of electricity such an arrangement of plates and insulator can hold at any given voltage depends on its capacity, and as mentioned previously, capacity is measured in farads. This unit, the farad, however, is much too large for all ordinary use, so the unit termed microfarad or millionth of a farad has been adopted.

The capacity in microfarads or mfd., as it is abbreviated, depends upon three things: the area of the metal plates, the distance between the plates and the kind of insulating material used. The insulating material may be air, glass, mica, hard rubber, dry paper and etc. Just how the kind of insulating material affects the capacity may be illustrated as follows: If we have a condenser with two metal plates one-eighth of an inch apart separated by air and measure its capacity, then slip a piece of glass about one-eighth of an inch thick between these plates, we will find that the capacity has become perhaps seven or eight times as great. Just why is this? All the different substances used for insulating the plates of a condenser have what is called a dielectric constant. Air insulation is the basis of measurement and the table, Fig. 3, shows the number of times (dielectric constant) the capacity is increased when other substances are used.

When a condenser is constructed for use as a grid condenser or phone condenser, paper insulation will do, but when a condenser is made to withstand a high voltage, much better insulation must be used, such as mica or glass. Good grid condensers usually use mica to reduce losses and not to withstand heavy voltages.

Condensers are formed by alternating metal plates with the insulating material used. Fig. 4 shows the method of constructing a grid condenser or phone condenser. Such a condenser is known as a fixed condenser, for the capacity is fixed and cannot be varied when it is finished. A condenser in which the capacity can be varied is usually the common rotating plate condenser, constructed of aluminum plates and using air as the insulating medium.

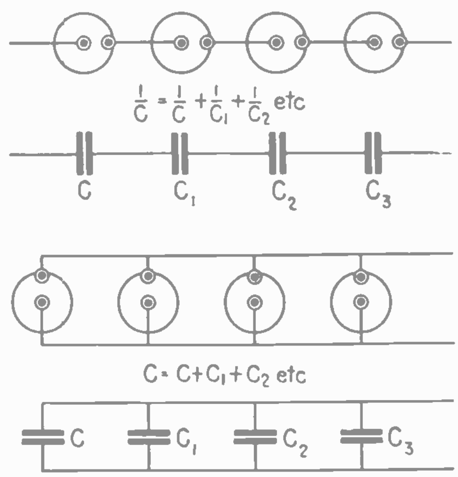


FIG.5

As with battery cells, condensers may be connected in series or in parallel. If condensers C, C1, C2, and C3 are of equal value, the total capacity when they are connected in series will be exactly one-fourth the value of one of them. In parallel, their value is 16 times that of the series connection.

A word here in reference to variable condensers which are commonly used will prove of value. It has become a custom to associate a condenser of .001 mfd. capacity as one having 43 plates and a condenser of half the capacity or .0005 mfd. as having 23 plates. It has been stated that the main factors controlling the capacity are the size of plates, distance between them and the insulation used. Air as insulation is one factor that is common to all variable condensers. No two condensers of different manufacture will be found to have exactly the same separation of plates and in practically all cases the size or area of the plates will vary. The closer the plates are together, the greater the capacity will be. Now how can a 23 large plate condenser with a separation of $\frac{1}{32}$-inch have the same capacity as a 23-plate condenser using smaller plates and perhaps smaller separation between plates? It does not stand to reason. Many times condensers of the same number of

(Continued on page 678)

How To Receive Radio Time Signals

By Kirk B. Morcross

MOST radio amateurs are interested purely in broadcast reception. Of course, this is to be expected since the reception of code is not particularly entertaining. Nevertheless, it is true that many broadcast listeners like to experiment for the sake of learning more of the fasci-

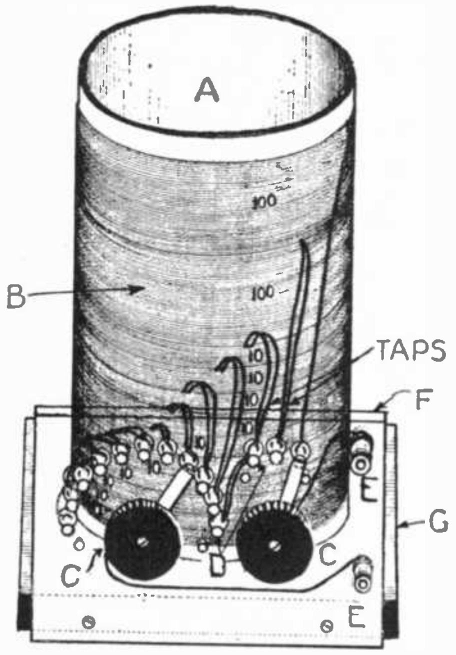


FIG. 1

Showing the completed tapped loading coil ready for use. The taps allow for fine tuning.

nating art of radio. To this end one's activities may be extended outside the field of broadcast reception. The reception of radio time signals from distant code transmitting stations offers an interesting and useful field of experimentation. To show you how to receive these time signals by adding a very simple and cheap device, namely, a loading coil, to your receiving set, is the purpose of this article. The loading coil (see Fig. 1) was designed by the Bureau of Standards, and this article will make clear every detail of its construction and use.

Radio time signals are broadcast at precisely definite intervals of time, from powerful code transmitting stations. These signals are based upon Naval Observatory time and may be picked up by radio receiving sets which are capable of tuning to the required wave-lengths.

Since the transmission of radio waves is almost instantaneous, the accuracy of the received time is not affected. You don't need to know the code in order to set your watch or clock from their time signals. The transmission merely consists of a series of dots covering a period of five minutes and ending with a long dash which indicates the exact even hour.

Broadcast stations sometimes "relay" these time signals after they have been sent out from the high power code transmitting stations. "Relaying" consists in picking up the time signals by means of a suitable receiving set and impressing the sound from these signals upon the microphone in the studio of the broadcast station in just the same way that the voice of the announcer is impressed upon the microphone. You cannot hear the original time signals with a broadcast receiving set because this set will not tune to the long waves.

Time signals, as originally broadcasted, come from continuous wave (CW) transmitting stations and from damped wave transmitting stations. The latter type of waves may be received with the loading coil when attached to a receiving set which does not use radio frequency amplification. Here is the list of damped wave stations transmitting time signals:

NAA—Arlington, Va.,
2,650 meters...11:55 A.M. and 9:55 P.M. E.S.T.
NAR—Key West, Fla.,
1,500 meters ..11:55 A.M. E.S.T.
NAT—New Orleans, La.,
1,000 meters ..11:55 A.M. E.S.T.
NAJ—Great Lakes, Ill.,
1,510 meters ..10:55 A.M. C.S.T.
NPW—Eureka, Calif.,
2,000 meters ..11:55 A.M. P.S.T.
NPL—Point Loma, Calif.,
2,400 meters ..11:55 A.M. P.S.T.
NPH—San Francisco, Calif.,
2,400 meters ..11:55 A.M. P.S.T.

NOTE: E.S.T. (Eastern Standard time) is one hour ahead of C.S.T. (Central Standard time), two hours ahead of M.S.T. (Mountain Standard time) and three hours ahead of P.S.T. (Pacific Standard time).

Refer to Fig. 2 and determine your approximate air line distance from these stations. Then, if possible, install a very large receiving antenna consisting of, say, one or more wires 200 feet long. You may then expect to receive the time signals in the *daytime* as follows:

When Loading Coil Is Used With:	Time Signals May Be Received from (Approximately):
Crystal set	200 miles
Crystal set and one-step audio amplifier	300 miles
Crystal set and two-step audio amplifier	350 miles
One-tube set	250 miles
One-tube set and one-step audio amplifier	350 miles
One-tube set and two-step audio amplifier	400 miles

The reason that the loading coil when used with a tube set does not give many times the receiving range which it does when used with a crystal set is because the addition of the loading coil usually prevents the tube-set from regenerating. Night signals from NAA will be heard from distances from *two* to *three* times as great as those given in the table. If you use the average size broadcast receiving antenna, the distances given above will be somewhat reduced.

The Loading Coil

Fig. 1 shows clearly all the parts completely assembled. The vertical panel is shown as if it were transparent. Here is the list of parts:

A. The form is a cardboard cylinder about 5½ inches in diameter and 8 inches long. For this a large size oatmeal box is excellent. One of the ends is left in position.

B. The winding consists of 300 turns or about 5 ounces No. 28 D.C.C. wire. You may use instead 300 turns of No. 26 wire and in this case about 6 ounces will be required. You cannot use much larger wire than this as it will not be possible to wind on the required number of turns. Taps for connecting to switch points are taken off when the coil is being wound.

C. Two switch blades.

D. Fourteen switch points.

E. Two binding posts.

F. A panel of thin, dry wood, 7 x 4¼ inches.

G. A baseboard 7½ x 7 inches and about ¾ inch thick.

If you want a more finished piece of apparatus, use composition insulating material for the panel. The wooden parts should be varnished to prevent warping.

Winding the Coil

Since the loading coil has a great many turns, it is a great advantage in winding it to secure portions of the turns in place so that they will not become loose. Fig. 1 shows the completed coil, and it will assist you in understanding how it is wound.

Fig. 3 shows a detail of the top of the loading coil and Fig. 4 shows it completely assembled. Starting ½ inch from the open end of the cardboard form (A), anchor the wire by weaving it through some small holes punched in the cardboard as shown at (R). Now wind on 100 turns of wire, punch two small holes in the tube, and push a loop of wire in one hole and out the other as shown at (S). Then wind on 100 more turns and bring out another loop. Wind the rest of the coil in this manner but bring out a tap at each *ten* turns. The coil taps progress around the winding form, affording convenient connections to the switch points. Make these taps just long enough to reach the required distance.

The third tap from the top of the coil should be long enough to connect to two switch points as shown at (D), Fig. 4, and also shown in Fig. 1. The completed coil has 13 taps counting the two single wires at the ends.

You may lightly varnish the turns of this coil, but this is not necessary unless it is to be used in a damp place.

Assembling the Parts

Mount the switch points, the switch blades and binding posts on the panel as shown in Fig. 4. Secure the panel to the base and connect the switch blades to the binding posts as shown by the dotted lines. Place the loading coil in position and connect the taps to the switch points, preferably by soldering. The taps must be connected in order so that when the switches are rotated out from the inside points, an increasing

FIG 2.

The above map shows some of the high-powered government stations which send out time signals daily. Generally, it is possible to receive all of them in any part of the country.

number of turns will be cut into the circuit. These connections are shown by dotted lines except that some of them which lead to contact points on switch (S) are, for the sake of clearness, omitted.

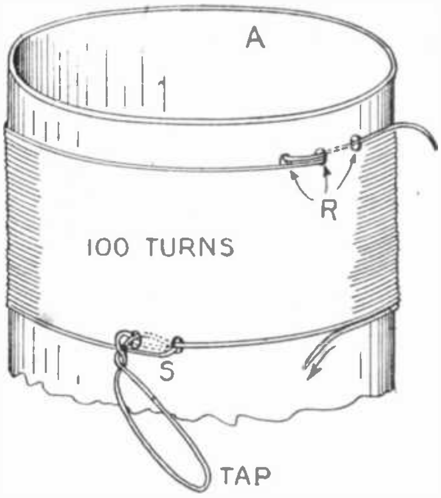


FIG. 3

Showing the method in which the wire is looped for taking off taps.

You may now secure the coil in position by small tacks driven through the cardboard end into the wooden base.

How to Use the Loading Coil

Connect the loading coil to the receiving set as shown in Fig. 4. This set must be of a type which does not employ radio frequency amplification. If the set has a series antenna condenser, equip it with a switch so that the condenser may be short-circuited. Also, if the set has a primary antenna circuit, bring out two wires from the terminals of the secondary coil or from the terminals of the variable condenser which is connected across this coil. These wires then represent the "antenna" and "ground" terminals of the receiving set. See that the switch blades on the loading coil make firm contact upon the switch points and that they rotate smoothly.

You are now ready to receive radio time signals from a code transmitting station. From the schedule of transmissions, note the time when signals are transmitted from the nearest station, making the necessary allowance for the difference in time in your locality. Adjust the receiving set so that it is tuned to a wave-length somewhere near the top of its range and set the loading coil switches on points (D), Fig. 2. Rotate switch (S) to the left, allowing it to rest a moment on each contact. Return switch (S) to point (D) and move switch (W) to point (C). Again rotate switch (S) to the left and return. Then turn switch (W) to point (e) and once more move switch (S) over the contact points. This process cuts in the turns of the loading coil, 10, 20, 30 and so on, up to 300 and you should at some time find the proper number of turns which will tune the set to the wave-length of the radio time signals.

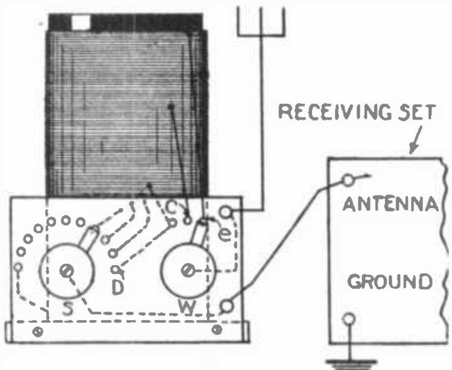


FIG 4

The hook-up used in wiring the coil to a set, which should preferably be of the three-circuit tuner variety.

The more turns you use, the longer the wave-length to which the loading coil will be tuned. Once the radio time signal is tuned in, you can recognize it easily by its steady repetition of dots which shows the way it is transmitted.

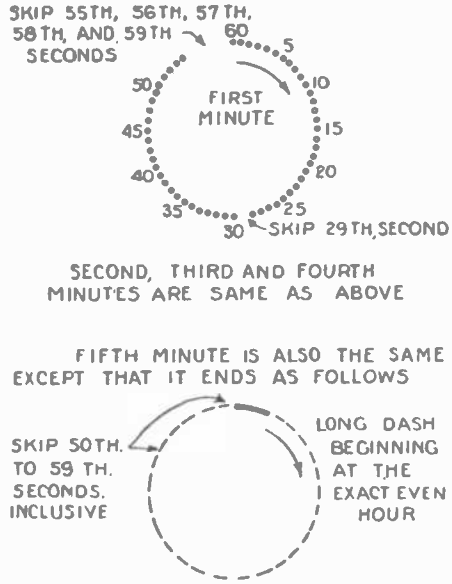


FIG 5

The manner in which the time signals are transmitted. Naval observatory time is most accurate.

When the long dash is transmitted at the end of the five-minute period, you can set your timepiece to the exact even hour.

Since the turns of the loading coil are varied by steps, you may sometimes obtain signals of greater intensity by making a part of the tuning adjustment on the receiving set. After you have found the proper adjustments for tuning in a signal, note the settings of the dials and switches so that you may again tune in the same transmitting station. When receiving broadcasting stations, set the loading coil switches on points (D), Fig. 2. The turns of the loading coil are then cut out of the circuit.

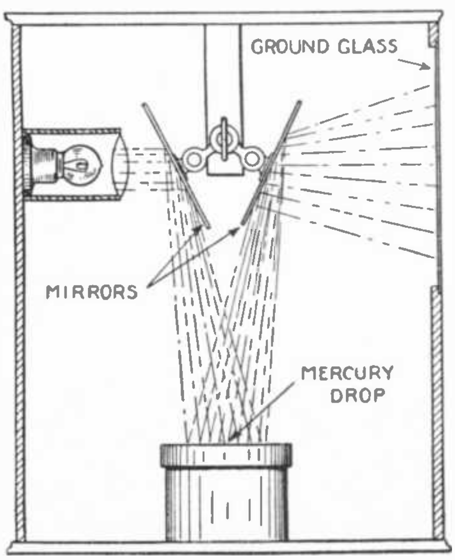
How to Make the Radio Tonoscope

(*Continued from page 660*)

glow is, of course, invariably of reddish color, but a little drop of mercury in the neon tube will give it a bluish tone, and it may be possible to get a pure red color by the use of a red glass cover for one of the tubes.

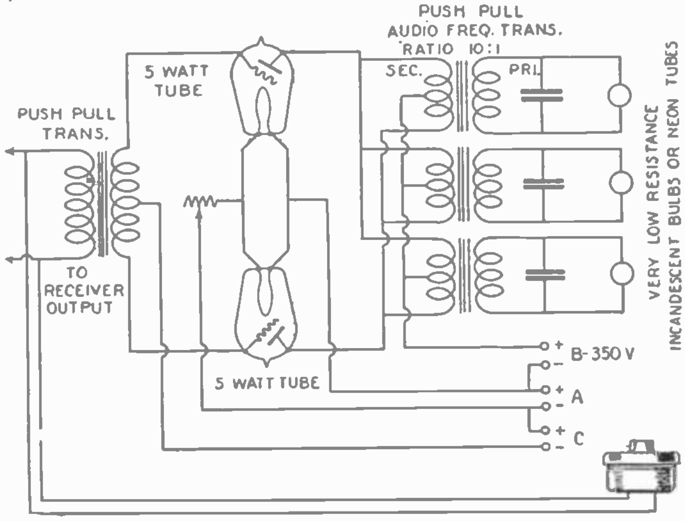
It must be noted that due to the fact that the light must fall directly on the mercury surface, the mercury drop cannot be inclosed in a glass covered case, and it is, therefore, necessary to keep the apparatus always upright while in operation. When the apparatus is not used, or when it is transported, the mercury must be removed.

All transformers, condensers and the push-pull amplifier may be mounted in one of the two types of cabinets here suggested. When properly constructed, the device will form a compact and very useful supplement to a radio receiving set. We hope that some of our readers will be induced to experiment along these lines.



Another and more efficient arrangement for the projection of the mercury drop pattern on the ground glass plate. Only one source of light is shown, but three small colored lights may be mounted in the set. The cabinet is made large enough to contain the necessary transformers and condensers.

Diagram of connections for a push-pull amplifier feeding three tuned circuits in which colored neon tubes are connected.



A Sure-Fire Five-Meter Oscillator

By Donald H. Menzel and Winifield Salisbury

THE prime necessity in the construction of short-wave apparatus is simplicity. This is especially true of apparatus which operates on wave-lengths between three and five meters. Care in design is well worth while. The sturdiness and simplicity of the oscillator described here are emphasized by results.

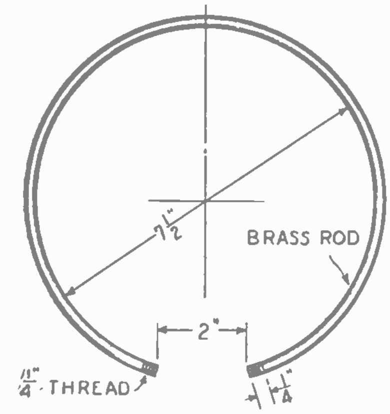


FIG. I

The main inductance which consists of a short length of brass rod or tubing. It should be thoroughly cleaned and polished.

Fig. 1 shows the inductance unit. It consists of a piece of ¼-inch brass rod 22 inches long, bent into a circle 7½ inches in diameter and threaded for ¼-inch on each end to receive the condenser plates. See Fig. 2 for the construction of these. The hexagonal brass nuts were soldered to the center of rough circles of ⅛-inch sheet brass cut out with a saw. This provides for chucking the plates in a lathe so that they can be turned smooth and polished and for mounting on the ends of the inductance unit as shown in the assembly in Fig. 3.

The stationary plate forms one plate of the grid condenser and the other plate consists of a 1-inch circle of sheet brass threaded on to a piece of ⅛-inch brass rod, held in place by a binding post mounted in the hard rubber inductance support. The frequency is controlled by a threaded brass rod with an insulating hard rubber tip which presses against the movable condenser plate. No grid leak is necessary because at the operating frequency the air between the plates gives sufficient leakage. The center clip which connects the inductance to the positive of the power supply, as shown in the diagram, is not of critical adjustment.

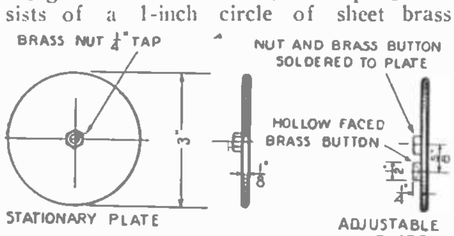
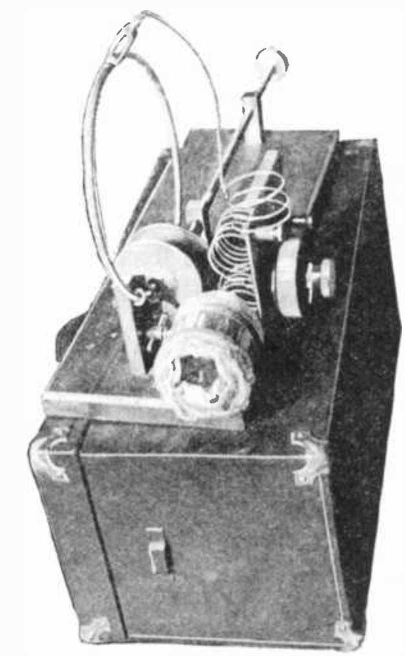


FIG. 2

Details of the condenser plates which can be of brass, copper, or aluminum, but preferably the former.



View of the complete five meter oscillator on top of its carrying case. Note the 5-watt tube with its base removed and vibrationless suspension. The key is connected externally.

Fig. 4 shows the "hook-up." It is in no way peculiar except that a by-pass condenser is unnecessary even when using a generator for the plate supply. This is apparently due to the high frequency generated. The radio frequency chokes shown in the diagram (Fig. 5) were made by winding four or five turns of ordinary square bus wire around a broomstick. The turns must be spaced about ¼-inch apart, to reduce the distributed capacity of the system. Three of them are necessary for the set.

For telegraph work a break-circuit key must be used if the oscillator is to be keyed as shown. A brass rod or copper tube about 7½ feet long, mounted as indicated in Fig. 4, makes an excellent antenna. It should be mounted in the plane of the coil of the oscillator inductance with the middle of it only a few inches away. Plate supply voltages up to 500 volts have been used successfully with a five-watt radiotron with the base removed, but 200 volts will suffice. A milliameter helps the operation, but is not absolutely necessary. As the filament is turned on, the plate current will increase slowly to about 45 milliamperes, and then as the tube breaks into oscillation it will drop suddenly to about 5 milliamperes indicating that the filament has reached its normal degree of brilliancy.

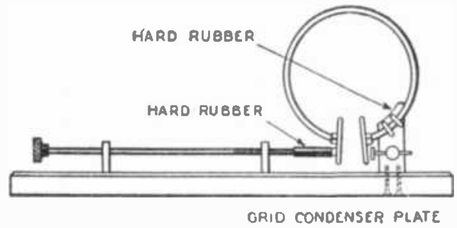


FIG. 3

Side view of the oscillator showing condenser adjustment arrangement and grid condenser. A dry hardwood base is used upon which are mounted the instruments.

The outfit may be adjusted for maximum radiation by changing the frequency until the plate current comes to a maximum again. Too close coupling with the antenna, however, may stop oscillation. This is indicated by too sudden a rise in the plate current. This oscillator covers a band of wave-length from 3½ to 9½ meters. Tests so far indicate that its range is from 300 to 500 miles. A photograph is shown of the completed set without the antenna.

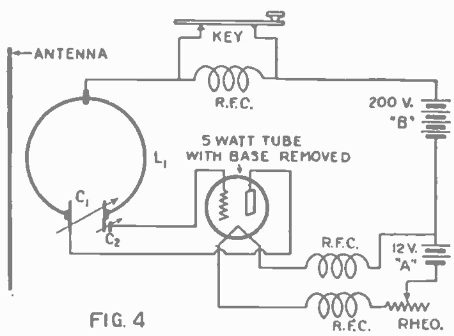


FIG. 4

The circuit used by the oscillator. Note that the antenna does not have a pick-up coil in its circuit, but is placed in close relation to the inductance.

A Word About Condensers

(*Continued from page 675*)

plates will vary 50 per cent. in capacity, so it is very important that a condenser be purchased by capacity and never by number of plates.

Just as batteries can be connected in series or in parallel, so may condensers. When condensers are connected in parallel, it has the effect of increasing the plate area and thus the resulting capacity will equal the sum of all the condensers. Fig. 5 shows this very clearly. If they are connected in series, they will act as one condenser having an insulating material as thick as that of the individual condensers combined. In this way the capacity of four equal condensers in series will be one-fourth that of one. When condensers of unequal value are connected in series, the total capacity is found by means of the simple formula given on the diagram. This total capacity will always be smaller than that of any single member of the group of condensers used.

It has been pointed out that alternating current will cause an electric strain or current flow. Now, the faster the change in frequency of the alternating current, the greater will be the average current. Rapidly alternating currents, as of radio frequency, cause greater current flow than corresponding alternating currents of slow periodicity, such as the 60-cycle house current. This is the reason why the effect of capacity anywhere in a circuit containing radio frequency is so great, such as excessive absorption due to wires running parallel.

The proper choice of condensers will do much towards bringing in the DX stations. Correct capacity condensers must be used where so advised and a poorly constructed condenser will cause losses in the vital parts of a tube circuit. A condenser with losses introduces practically just so much more resistance in the circuit, and where such a condenser is used for tuning, the resistance of it will cause a very selective circuit to tune broadly.

Do not always blame the circuit or antenna. Be careful of the condensers used in any new set you are making, and choose them only after due consideration.

The EXPERIMENTER Radio Data Sheets

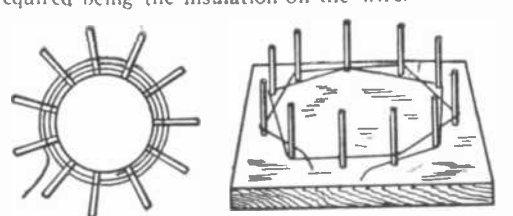
By Sylvan Harris

TYPES OF COILS

THE design of the simple cylindrical coil was discussed in radio data sheets 4-10 to 4-13, the design of other forms of inductance coils is not so simple, and the best way for the experimenter to build them is by the cut-and-try method.

The purpose of this data sheet is to acquaint the reader with some of the various other types. The simplest form of winding other than the simple tubular coil is generally known as the Lorentz type. It is easily constructed by means of a pin-board, as illustrated. A small piece of board is drilled with a number of holes arranged equally spaced in a circle. These holes can be spaced at the option of the experimenter, and the diameter of the circle in which they are laid out is also up to him.

The inductance of this type of coil differs slightly from that of the ordinary cylindrical coil, but the difference is not very great, so that the values of inductance as obtained from the charts in 4-11 to 4-13 can be approximately applied. The Lorentz coil is an approach to the simple cylindrical coil. It is a cylindrical coil of one layer of turns, the turns being bent out of shape so as to make the coil self-supporting. This design of coil is generally very good, having about the same resistance as the cylindrical coil, and having very low coil (distributed) capacity. Furthermore, since the coil is self-supporting, losses due to absorption or leakage in insulating material are avoided, the only insulating material required being the insulation on the wire.



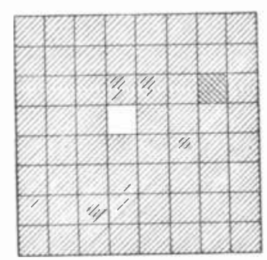
Another method of winding inductance coils is known as the spider-web method. This is also illustrated in the figure, and is made on a hub with a number of spokes arranged radially about the axis. There are, however, certain disadvantages connected with this type of coil, as although it has low coil capacity, since the inner turns contribute little to the inductance of the coil, more wire has to be used to obtain a given inductance. Furthermore, the skin-effect in this type is likely to be very great, so that the coil is decidedly inferior to the Lorentz type or the cylindrical coil.

The EXPERIMENTER Radio Data Sheets

By Sylvan Harris

CURRENT DISTRIBUTION

RADIO Data Sheets 1-3, 4 explain the idea of resistance in direct current circuits. In alternating current circuits, when the frequency of the current is very high, as is the case in radio circuits, the effective resistance of the conductor may be many times its resistance to direct currents. The reason for this is as follows:



The simple relations explained in 1-3, 4 are only for cases where the current is distributed uniformly throughout the cross-section of the conductor or wire. For the sake of simplicity, if we assume a square conductor, such as depicted in the figure, divided into squares, and also assume that the amount of current in all the squares is the same, we will have a representation of a uniformly distributed current.

Now suppose we take the current out of one of the squares and put it into another square. It will be evident that the total amount of the current flowing through the conductor will be the same as before; we have not altered the amount of the current but only its distribution.

Now, in data sheet 1-3.41 we have seen how the resistance of a conductor can be regarded as a measure of the amount of heat generated in the conductor by the passage of the current through it, and have seen that the rate of energy dissipated in the form of heat is proportional to the *square* of the current, *i. e.*, $P = RI^2$. In other words, if we double the current in the conductor, the power loss due to heat will be quadrupled.

By changing the current distribution as described above, we have reduced the heat loss in the one square to zero, while we have quadrupled the loss in the other square. Thus, without changing the actual value of the current, the conductor will act as if its resistance is higher than it really is, due to the unsymmetrical current distribution.

The EXPERIMENTER Radio Data Sheets

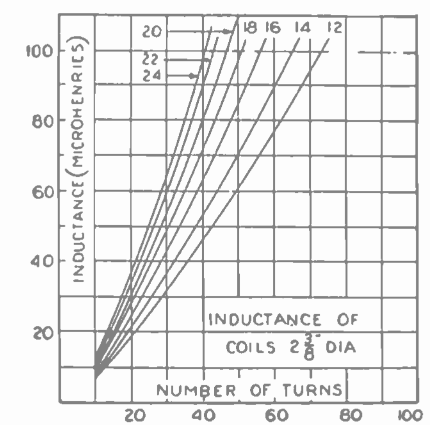
By Sylvan Harris

INDUCTANCE CHART

IN Radio Data Sheet 1-33 we have shown how the various values of inductance and capacity in the tuned circuits of a radio receiver may be determined easily. The method shown employs a chart that requires no computation on the part of the experimenter. In Data Sheet 4-11 was given a chart that enables the experimenter to build his coils so that they will have the inductance which he requires in his tuned circuit. The chart given in 4-11 applies only to coils 3 inches in diameter.

Not all coils are built to have diameters of 3 inches, so to enable the experimenter to make his own choice of coil diameter, we present in this sheet charts that will apply to coils of other diameters. The various diameters are 2⅜ inches, 3⅛ inches and 4 inches.

In the construction of the coils, which the experimenter is going to use in the tuning circuits of his radio receiver, there are many precautions to be followed so that best results will be obtained. The construction must be such that the inductance of the coil will not change. This requires that the coil be built solidly so that the turns of wire cannot move with respect to each other, and cannot be bent out of shape. He must also remember, especially when he is considering any of the "trick" methods of winding coils, that the greatest amount of inductance for a given length of wire is obtained when the turns of the coil have a circular shape.



The EXPERIMENTER Radio Data Sheets

By Sylvan Harris

TYPES OF COILS [Continued]

The Lorentz and the spider-web types of inductances were described in radio data sheet 4-20. Other forms of coils are pictured on this sheet. One type of coil that was very popular on account of the fact that it was easily removable from the circuit by means of mounting plugs, is the honeycomb coil. A coil very similar to this in general appearance and operation is known as the duolateral coil. This differs from the honeycomb coil to a slight degree in the disposition of the turns.

These two types are multi-layer coils. As a result of the multiplicity of layers the coil capacity in multi-layer coils becomes very appreciable, and means must be found to keep this low, or else the resistance of the coil would be considerable.

In the honeycomb and duolateral types of coils, the wire as it is wound around the cylindrical core on the winding machine, oscillates from side to side. The turns of wire are spaced as the winding progresses, and the turns of each layer are arranged so that they fall between the turns of the layer beneath it. This gives to the coil a honeycomb appearance, hence the name.

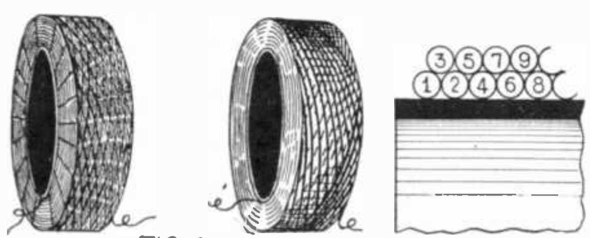


FIG. 2

In another form of multi-layer coil, known as the bank-wound coil, the arrangement is as follows: Instead of winding the several layers in the ordinary fashion, where the turns are wound on from one end to the other and then back again, the turns are arranged in accordance with the scheme shown in the diagram. The succession of turns is indicated by the numbering in the diagram. Any number of layers may be built up in this way, the advantage of the method lying in the fact that the voltage between adjacent turns in adjacent layers is not as great as in the ordinary multi-layer coil. This makes the coil capacity lower than it would be otherwise.

The EXPERIMENTER Radio Data Sheets

By Sylvan Harris

CURRENT DISTRIBUTION [Continued]

In Radio Data Sheet 1-20 we have seen how the resistance of a conductor of electricity is increased above its resistance to direct currents, when the current in the conductor is not uniformly distributed throughout its cross-section. It does not matter what distribution the current may have; as long as the distribution is unsymmetrical, the resistance will be higher. This can be shown analytically, but it will be sufficient for our readers to take it for granted until later on.

The next question that will arise in one's mind is: "For what reasons will the current in a conductor ever be distributed unsymmetrically?" To answer this we must consider what goes on in a conductor carrying a current. We all know this: as the current flows, it establishes a magnetic field about itself. If the current is varying in intensity as it flows, the magnetic field also varies simultaneously. The variation of this magnetic field causes an electromotive-force to be *induced* in the conductor, which is in a direction opposed to that of the current. It is known as a "counter-electromotive-force" and is often abbreviated "C.Emf." The faster the variation of this magnetic field, the greater will be the C.Emf., and it follows likewise that the greater the current and the more intense the field, the greater will the C.Emf. be.

Now, the field is most intense at the center of the conductor, if the conductor be round, as an ordinary wire. For this reason the C.Emf. will be greatest at the center of the wire, and will offer more opposition to the flow of current at the center than near the surface. As a result, the current will be forced to the surface of the wire and be made to travel in its "skin." Hence the effect is known as the "Skin-Effect."

The more rapid the variation of the field, or, what is the same thing, the frequency of the current, the greater will be the skin-effect. Furthermore, the effect is greater in thick wires than in thin ones since there is more body in the large wire in proportion to its surface, or skin.

The EXPERIMENTER Radio Data Sheets

By Sylvan Harris

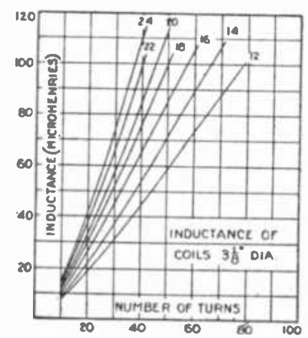
INDUCTANCE CHART [Continued]

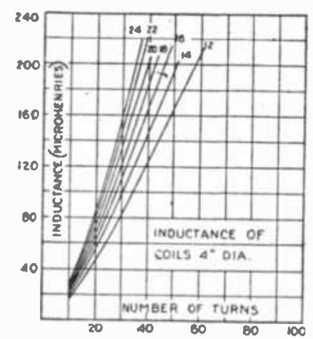
THE use of the charts on this sheet was described in Radio Data Sheet 4-11. These charts enable the experimenter to build coils having inductances of prescribed values, the diameters of the coils having the values noted on the charts. The charts on this page apply only to coils having diameters of 3⅛ inches and 4 inches.

The method to be followed in using these charts was outlined clearly in Radio Data Sheet 4-11. The precautions to be followed in allowing a few extra turns described at the bottom of that sheet should be carefully noted.

In following this chart, the experimenter must remember that the values obtained from it are not exact. The inductance of a coil depends on other things besides the actual number of turns of wire on it, as for instance, the degree of coupling between it and any other electrical circuit, either connected to it or in proximity to it.

It has been explained in data sheet 4-11 that when another coil, as for instance, the antenna coil, is coupled to the one we are designing, the effect is to decrease the effective inductance of the secondary coil. This requires that provision be made for extra turns. The actual number of extra turns required depends upon the length of the antenna, or rather, the constants of the circuit which is coupled to the coil, and the closeness of the two coils. It is always better practice to build the coil with a few extra turns, as it is easier to remove a few turns of wire than to build the complete coil again.





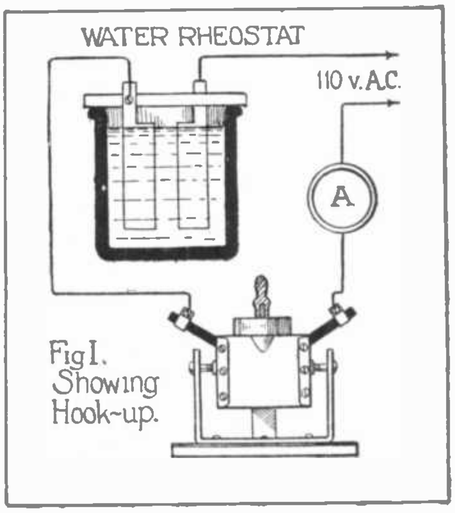
CUT ALONG PERFORATED LINES

Electric Arc Crucible

By Philippe A. Judd

HISTORY shows us that on all parts of the globe—no matter how far separated by space or time—the advance of civilization has been coincident with man's discovery and use of the metallic elements and alloys.

Any laboratory supplied with the usual 110-volt A.C. lighting circuit possesses the facilities for obtaining one of the highest temperatures yet produced by man, that of the electric arc, 3500° C. (6332 F.), at which carbon vaporizes. This is the temperature of the relatively small space between the electrodes; otherwise one would experience no little difficulty in its regulation. As it is, the arc may be inclosed, together with the substance to be melted, by some non-conducting material, which will conserve the greater portion of the heat engendered, and thus cause the fusion of the material to be melted.



Connections of the electric arc furnace, showing a water rheostat, ammeter, and the furnace proper on its journals.

The electric furnace described includes an electric arc provided with a suitable housing which also forms a crucible for the molten metals. It was designed for experimental purposes, the dimensions given making it suitable for use in the laboratory and for the casting of small pieces. Its construction permits the contents of the crucible to be poured directly into the mould without the use of the customary tongs or ladle, and avoiding wasteful transfers.

The arc is wired in series with a rheostat capable of passing 8 or 9 amperes for several hours without undue heating, a water rheostat probably being the best for this purpose. One may readily be prepared by immersing two copper plates in a two-gallon earthenware jar of salt water. After striking an arc, salt should be added until the ammeter reads about 7 amperes (see Fig. 1).

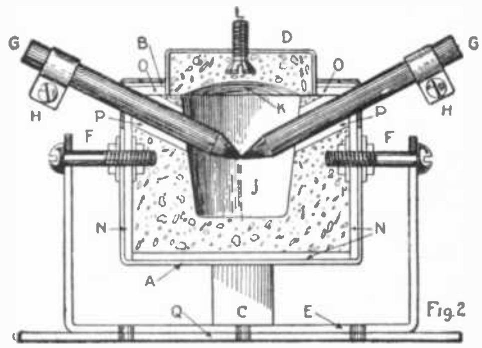
In Fig. 3 is given a pattern for the case, which is cut out of rather heavy sheet steel (about 20 gauge), and is then bent up and bolted or riveted as shown in Fig. 2. A tin can of suitable dimensions might be substituted for this, although it would scarcely make so serviceable a case. The interior is lined with asbestos board, one-eighth inch thick.

The two 8/32 stove bolts (F) are firmly clamped to the sides with nuts and washers and serve as pivots on which the crucible swings in the bearings of the yoke (E). The leg (C) is bolted to the back of the case, together with the handle (M) to steady the crucible and prevent it from swinging. The yoke (E) is a 12½-inch length of 1/16-inch x 1-inch strap iron, drilled, slotted and bent as shown. It is mounted near the edge of the asbestos-covered base to facilitate pouring.

The arc electrodes (G) are regular ⅜-inch arc light carbons, about 6 inches in length and are provided with copper terminal clips (H).

When the case has been assembled and lined, it is ready for the refractory filling. This consists of powdered fire clay and asbestos wool, mixed to a stiff putty-like consistency with water. The clay should predominate, the asbestos serving both as a non-conductor and a binder. The lute thus formed is packed around the inside of the case and well tamped. A small flower pot, such as are used in greenhouses for seedlings, serves very well to form the crucible cavity (J) and should be smeared with vaseline to prevent the clay sticking to it. The carbons slide through asbestos board bushings (P) which are formed by rolling a single thickness of the sheet about the carbons. When the filler has reached the height the electrodes are to occupy, the wrapped carbons are laid in place and the packing is completed.

The cover (D) is a tin can lid, 2½ inches in diameter, filled with the lute. It has a cavity (K) scooped out of its underside to form a reflector. It has a stove bolt (L) embedded in it to serve as a handle which may be provided with a knob. The lute should be allowed to thoroughly dry before the steel (B) and asbestos (O) tops are put in place. This will require several days, at least. With the top pieces clamped securely in place by the flanges and the whole mounted on a suitable base or bench top, the furnace is ready for use.



Sectional view of the furnace, showing clearly all parts. The chamber may be formed with a small flower pot as the matrix to be withdrawn when the lining has dried out.

A small vent, formed between the arris of the cover and the channel (I), will permit the escape of any gases formed. Care should be taken to place the furnace under a ventilating hood, or in the open, when arsenic, mercury or phosphorus is to be added to the contents of the crucible, as their vapors are very poisonous.

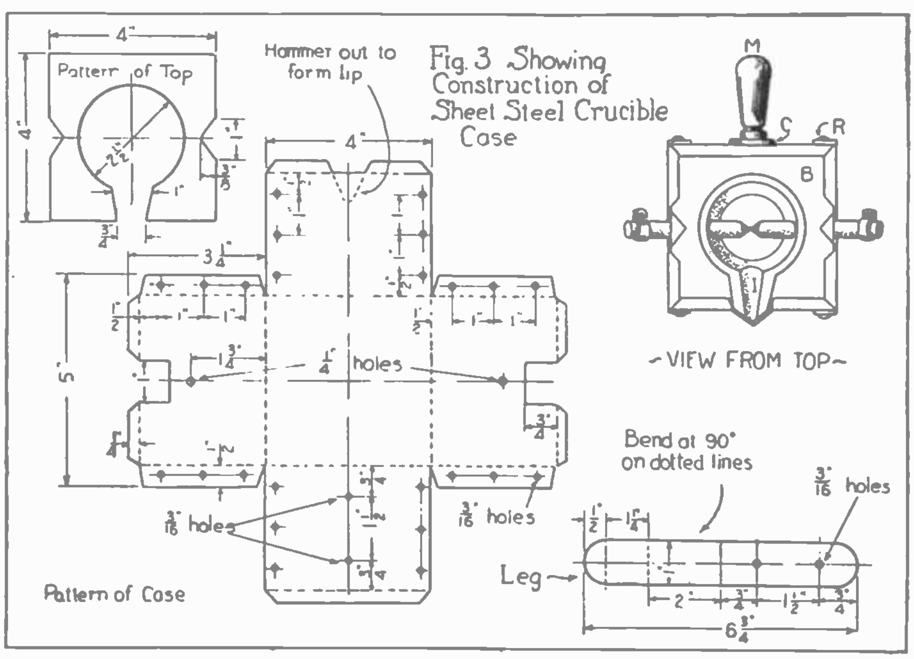
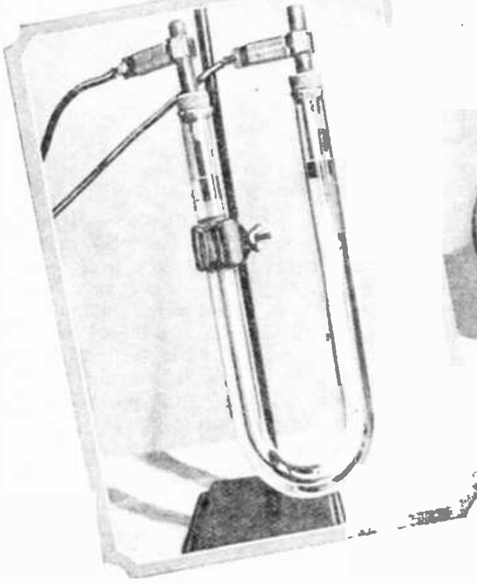
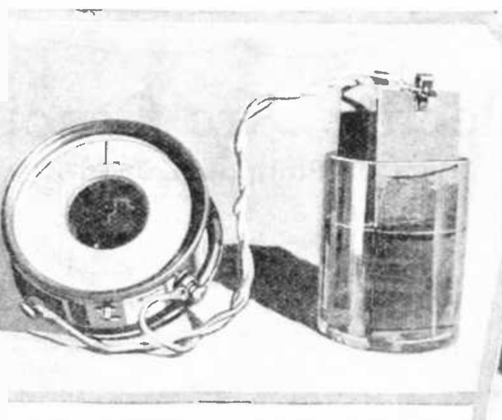


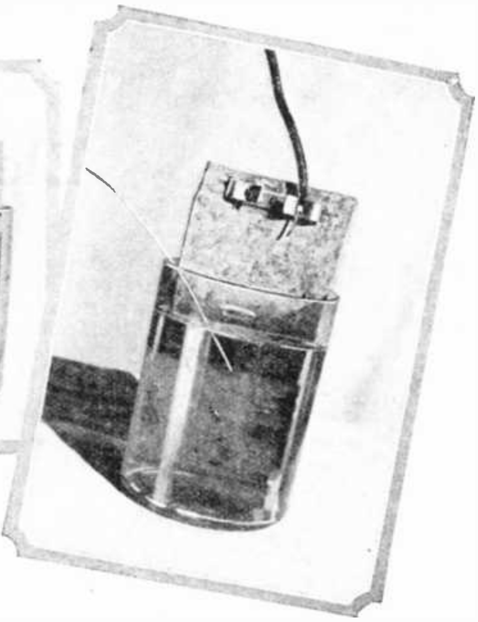
Diagram with dimensions of the various parts of the furnace-jacket and the view of the furnace showing the spout or lip through which the fusion is poured.

Experiments in Electrochemistry

By Raymond B. Wailes



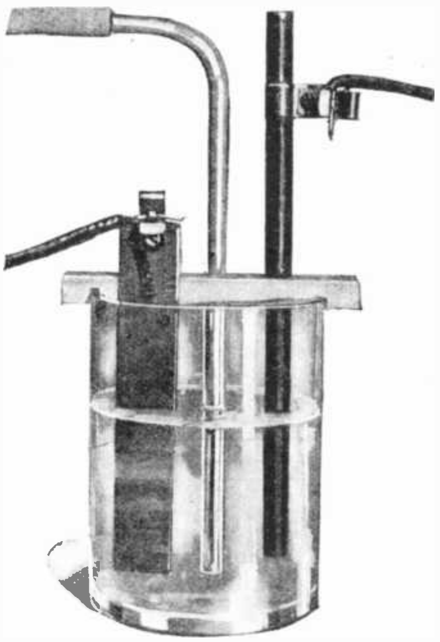




Left: A U-tube mounted for electrolytic work such as the production of iodoform or aniline black. Above: Photoelectric cell which produces its own current when acted on by light. Right: The electrolytic forge, an iron wire immersed in a liquid is heated white hot in this fascinating experiment.

EXPERIMENTS in electrochemistry are very fascinating and at times very mystifying. Some electrolytic dissociations are very awe-inspiring, the actual tearing apart of molecules can be almost visualized. For instance, we know that salt is a compound of sodium and chlorine and that the sodium which it contains is a soft, silvery metal which oxidizes upon contact with water. The chlorine is a greenish, yellowish gas, at one time used as a poisonous war gas. But to separate these constituents from the salt after they have been chemically combined together is an art in itself. However, it can be accomplished with the aid of the electric current.

For this experiment a solution of salt in water is required. Table salt will do. Immerse the positive wire of the 110-volt direct current house system in the salt solution and place a 100- or 200-watt lamp in series with it. Now touch the negative wire to the surface of the salt water and withdraw it from the adhering surface as much as possible, but maintaining contact. It is possible at this point to keep the end of the negative wire seemingly white hot, for yellow sparks will fly from it in every direction. This is due to the sodium ions in the salt water being attracted by the negative wire losing their electric charges which make them ions and, as they again become molecules, they immediately react with water, "burning" as they do so. It is not possible to produce metallic sodium in the form of a lump or mass by this simple electrolysis. A storage battery will serve as well as the 110 volts direct current.



Gases can be introduced through the glass tube into a solution which is being electrolyzed, so as to obtain different reactions.

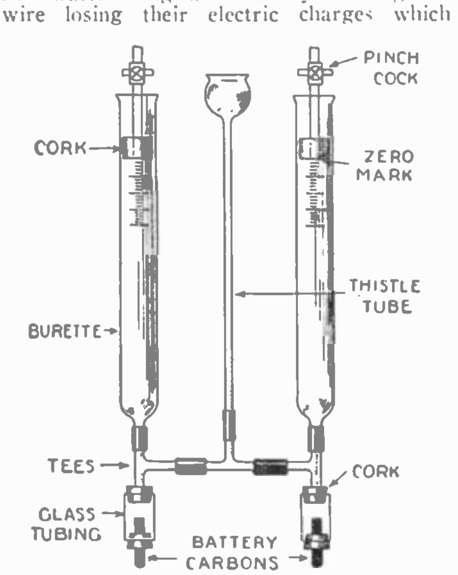
Another experiment resembling this one is unique. It really resembles an electrolytic forge. A sheet of lead is made the positive electrode in a potassium hydroxide solution. A bare iron wire is made the negative electrode. This wire should be held in the hand. The source of current should be 110 volts direct potential with an electric flat iron in series with it, so that about 5 amperes can be pulled through the circuit. A suitable resistance of nichrome wire is excelent instead of the flat iron. Ten amperes with a resistance works better. A storage battery can be also used, for the source of current.

The solution of KOH should be heated to boiling in a beaker and the lead electrode then inserted after removing the Bunsen burner flame. Upon introducing the iron negative wire electrode, it will become heated red, and then white hot, due to the separation and immediate reaction of the potassium at the electrode The iron wire will very likely melt, even if it is one of a fairly large size. This experiment is very striking since the production of an apparent fire beneath a liquid seems almost miraculous.

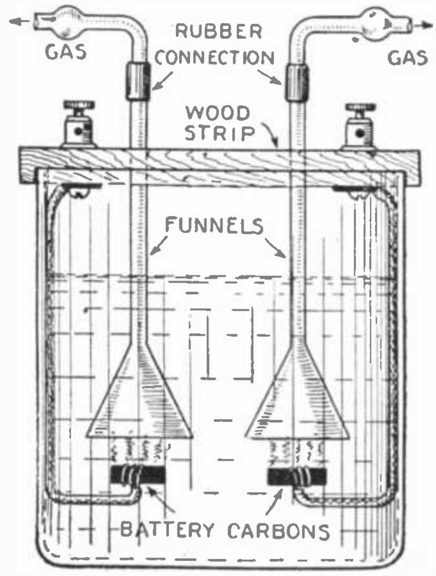
A U-tube affords a very good device for electrolytic experiments. Using 5 grams of potassium iodide, 10 grams of sodium carbonate and 10 c.c. of medicated rubbing alcohol and 90 c.c. of water, the whole being electrolyzed with carbon electrodes in the U-tubes for half an hour, iodoform, an antiseptic, can be produced and recognized by its odor. It will settle in the bend of the tube.

A black dye, aniline black, can also be made by using 20 grams of aniline and 20 grams of toluidine which have been neutralized by about 30 c.c. of strong acetic acid and then dissolved in 150 c.c. of water. Electrolyze the whole.

A stand for electrolysis can be made from a foot length of glass towel bar not quite half an inch thick. Corks carrying the different electrodes can then be held to the



A simple apparatus for the decomposition of water and the collection of the separate gases as described above.



Another apparatus for the decomposition of water. Two inverted funnels are provided to collect the gases given off at the electrodes.

glass non-conducting pillar-post by burette clamps.

A simple form of electrode support can be made from a strip of wood drilled to carry the round carbon rod electrodes if they are used, and the wooden strip is to be laid across the top of a beaker. By varying the number of electrodes various areas of active surface can be used in the electrolysis.

A typical electrolytic chemical preparation, ferric oxide, can be produced by using a carbon cathode (negative electrode) and a strip of iron as the anode. The electrolyte

Production with simultaneous oxidation of metallic sodium by electrolysis.

or solution is sodium sulphate dissolved in water. Use direct current. The electrolysis gives iron hydroxide which is soon oxidized to ferric oxide by blowing air through the sodium sulphate solution. The air can conveniently he led through the solu-

A glass support for electrodes; the rod is taken from a towel rack. The use of glass for the supporting rod ensures good insulation of the electrodes.

tion by means of a bent glass tube. The carbon and the iron electrode and the glass tube for the oxidizing air can all be carried by a wooden strip running across the beaker used for the electrolyzing vessel

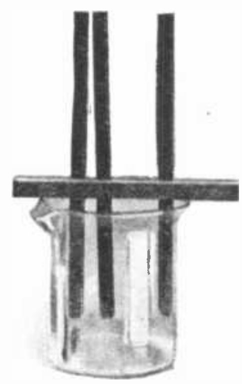
A photoelectric electrolytic cell which will produce a small current when one of its plates is illuminated can be very easily made by the experimenter. Take two aluminum sheets and boil them in a dilute ammonium hydroxide solution. This will put a white coating of oxide upon their surfaces Now cautiously heat both plates and spread a bit of selenium upon one of their surfaces with the back edge of a hack saw blade. You will find that the selenium will adhere to the oxide coating. Soon the surface of each plate will be coated with a glossy black form of selenium. Now carefully lower the flame and keep the plates at such a heat that the black glossy coating becomes slate grey. When the selenium surfaces have become of this color, cool. It is useless to work with the black glossy coatings

Insert the two plates, uncoated surfaces back to back but not touching, in a glass cell containing salt water. Connect the electrodes with a millivoltmeter or galvanometer. When one of the selenium surfaces is exposed to a fairly bright source of light, an electric current will be produced in the cell. It is not necessary to use a battery with this photoelectric cell. It generates its own current.

Nobili's rings may be made to appear in the simplest experiments in electrolysis. Take a bright silver quarter or half a dollar and lay a drop of copper acetate solution in the center of it. Now touch the center of the silver coin with the sharp end of a strip of zinc. Nobili's rings, a series of copper circles, will start to form from the center and spread toward the edge, if the coin has been wet all over with the cupric acetate solution.

At right is shown the production of a Nobili's ring on a silver coin. This experiment can be developed so as to produce really beautiful color effects in varied designs.

An apparatus for the quantitative decomposition of water can be made without glass blowing, from two burettes. They are fitted together with a tee and short lengths of glass tubing. A cork carrying a glass tube is inserted into the open end of each tube and depressed inward, so that the end of the cork is just flush with the zero mark of each burette. The whole apparatus is



A simple electrolysis apparatus in which the active area of electrodes can be changed by pushing them up or down.

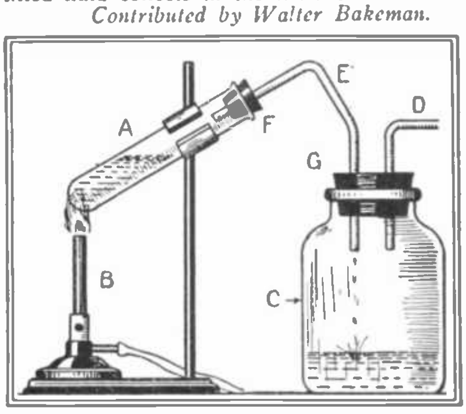
filled with weak sulphuric acid water through the thistle funnel in the center, and the electrolyzing current from a battery is made through the carbon electrodes in the bottom of the apparatus.

Condenser for Distilling

THE illustration shows a condenser for the amateur's laboratory.

(A) is a test tube from which the fluid is evaporated by the Bunsen burner. The distillate passes through the tube (E) into the flask (C), which is kept cool. The tube (D) acts as a safety valve and lets in air. (F) and (G) are corks through which the tubes pass; they should fit tightly. The distilled fluid collects in the flask C

Contributed by Walter Bakeman.



A jar replaces the ordinary Liebig's condenser in the distillation of liquids. As the jar will soon get hot, it may be immersed in a larger jar of water, kept overflowing.

Chlorine Gas Test

USUALLY the experimenter has to resort to some roundabout way for detecting chlorine gas, frequently using methods which are not sensitive enough to detect small quantities. In a very few moments, and at the cost of a very few cents, an interesting little piece of apparatus can be prepared which is delicate enough to show the presence of chlorine gas in proportion too small to be noticed by any living being except a canary bird.

To prepare a chlorine gas detector, simply push a wad of glass wool (sold as Christmas tree decoration under various names such as "Angels' Hair," etc.) down a glass tube, fill a portion with potassium iodide, above the glass wool, and plug the end with another wad of glass wool The ends of the tube can be closed with wax until desired for use.

When chlorine is passed through the tube, it displaces iodine: $2KI + Cl_2 = 2KCl + I_2$. The free iodine imparts a deep reddish-brown color Bromine has a similar effect, but can be distinguished from chlorine by means of carbon disulphide which is made reddish-brown by bromine. Best results can be obtained with the iodide tube if the potassium iodide is slightly moist.

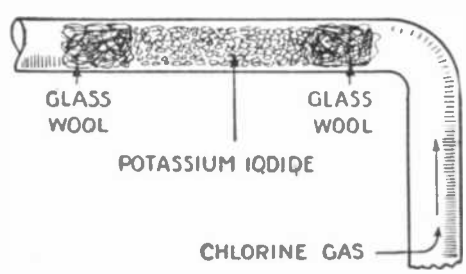
Contributed by W. B. Leffingwell.

Laboratory Stand

A CONVENIENT laboratory adjunct of extreme simplicity in construction can be made by taking an 18-inch length of ⅛-inch steel wire, and bending it to form a horizontal loop at one end. The other end is then filed to a point and driven into a 1-inch board measuring 4 x 6 inches.

It finds chief use in supporting the smaller long-stemmed funnels, so convenient in small quantity filtration, thereby relieving the regular ring stand, which ordinarily will not hold the small funnels for larger work.

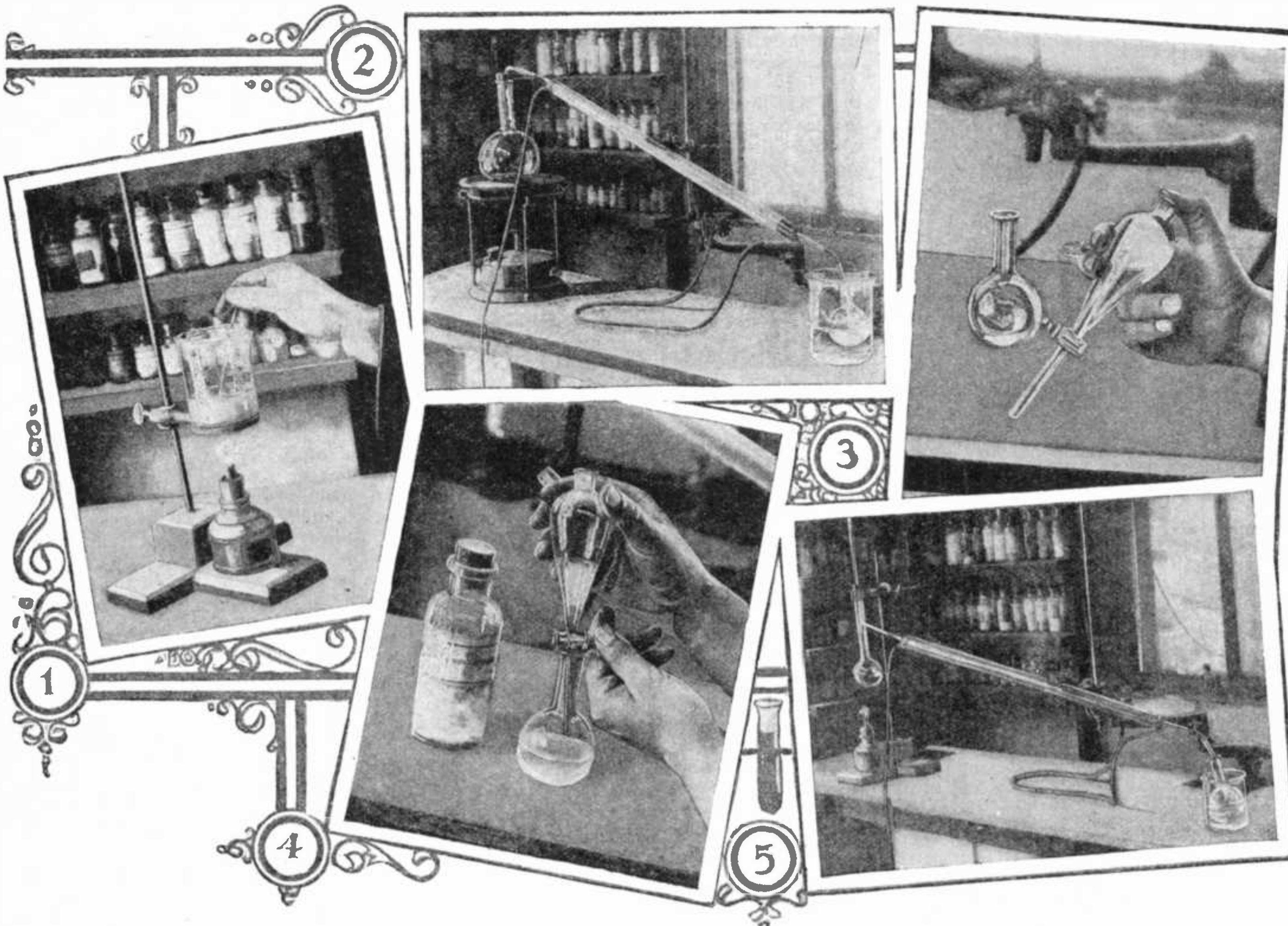
—*Contributed by S. J. Ross.*



Potassium iodide in a glass tube, held in place by glass wool, detects chlorine gas. The liberation of iodine from the potassium iodide by the chlorine imparts a brown color to it.

Obtaining Derivatives of Paraffins

By Dr. E. Bade



1—Ethyl iodide is prepared in a beaker containing potassium carbonate, water and alcohol; it is heated and iodine is added. The iodine combines with the ethyl radical of the alcohol replacing the hydroxyl. 2—Potassium bromide is used to make ethyl bromide; the mixture of alcohol, sulphuric acid, potassium bromide and water is placed in a liter flask and distilled through a long condenser. Be sure to distil upon a sand bath. 3—Wash the ethyl bromide with water, using a separatory funnel. The mixture can be agitated thoroughly to wash out other compounds, and can be separated owing to its specific gravity. 4—The ethyl bromide is dried in a small flask, the drying being carried out with calcium chloride. 5—Redistil the ethyl bromide from a small fractioning flask, using a very tiny flame, a long condenser and a receiver standing in ice water.

ALTHOUGH the paraffins are comparatively inert to chemical action, the halogen derivatives, where one or more hydrogen atoms are replaced by chlorine, bromine, etc., form an important group of reactive compounds. The substitution of a halogen for hydrogen, although it may, under certain circumstances, take place directly in diffused light, is more easily prepared from the corresponding alcohol. Then, too, it is very difficult to stop the reaction at a certain place when direct substitution is resorted to, while the pure substance is readily prepared by the indirect method.

Chloroform, carbon tetrachloride, iodoform, ethylbromide, etc., all belong to this class. Their use is various and manifold, ranging from solvents to anæsthetics and fire extinguishers, surely a class of prime importance. And many are easy to prepare so that they may be studied at leisure.

Chloroform is most readily prepared with bleaching powder and acetone. Mix 100 grams of bleaching powder with 400 c.c. of water to form a paste. Place in a 1-liter flask and arrange the apparatus for distillation by passing a goose neck through the cork and adding a long condenser. Catch the chloroform, as it distills, in a small flask.

Carry out the process as follows: When the apparatus has been arranged, add 30 c.c. of acetone and gently heat the flask. When the mixture begins to bubble (it should not distill as yet), remove the flame until the reaction has moderated. Then boil the contents of the flask and distill slowly until no more oily drops come over.

The chloroform is not yet pure; it must still be washed with sodium carbonate solution in water. Use about 10 c.c. of this solution and wash twice. Remove the wash water by means of a separatory funnel and place the chloroform in a dry flask. Add a few pieces of calcium chloride to remove the last trace of water and re-distill. This substance is now a heavy, colorless liquid which boils at 61° to 62° C. (140°—142° F.) and it is non-inflammable. Keep the chloroform in a dark-colored bottle which must be tightly stoppered.

Chloroform has three of the four hydrogen atoms of marsh gas substituted by chlorine. It is an anæsthetic and passes, as such when used by doctors into the blood vessels by respiration, and it is also used, to some extent, as a solvent for fats. Iodoform, on the other hand, is an excellent antiseptic and disinfectant containing three iodine atoms. It is prepared by dissolving three grams of potassium carbonate in 20 c.c. of water and adding 5 c.c. of ethyl alcohol. Warm the mixture to about 70° C. (158° F.) and add four grams of powdered iodine gradually. Let stand for a few minutes and stir. Then filter and wash the yellow precipitate with a little water. Let it dry. By recrystallizing the iodoform with the aid of alcohol, using just a little of the solvent and warming, the iodoform is purified. It produces hexagonal crystals which melt and sublime at 119° C. (246° F.), but because of its peculiar odor, it is seldom used as an antiseptic today.

The importance of the monohalogen derivatives of the paraffins lies in the great variety of chemical changes which they undergo, a peculiarity strikingly different from that of the paraffins themselves. The bromine or iodine atom, when present in the paraffin, is more reactive and easily removed than the chloride atom.

Ethyl bromide is a typical monohalogen derivative such as alluded to above. It is conveniently prepared from ethyl alcohol (that type, marked for external use only can be employed). Into a liter flask put 100 c.c. of concentrated sulphuric acid and quickly add, with constant stirring, 100 c.c. of ethyl alcohol (95 per cent.). Cool to room temperature and slowly add 70 c.c. of cold water, at the same time cooling the flask in ice water. Then add 100 grams of potassium bromide which must be finely powdered, the bromide being added when the solution in the flask is cold. Place on a sand bath and distill the mixture. The sand bath consists of a metal tray or pie plate on which fine sand is placed to the depth of about one inch. The flask is placed on the sand and the tray is strongly heated. The heat is transmitted through the sand to the flask. Chemists often do not use the sand, but only the plate. A long condenser is required, and it is much better to use two, for the ethyl bromide boils at 38° C. (100° F.). Also keep the receiver in cold water, or better yet in a freezing mixture of ice and salt to prevent the evaporation of the liquid as it comes over. Two layers will be formed, the ethyl bromide, being the heavier, will be on the bottom of the flask while the water, which also comes over, will float on the surface. Watch the process of distillation carefully, because the flask, containing the reaction mixture, will froth considerably at times, which is the reason why the large liter flask is taken for the comparatively small amount of chemicals used.

When no more oily drops come over, the reaction is complete. Wash the lower layer several times with water, then with a dilute solution of sodium carbonate in water. Carefully place the ethyl bromide in a clean, dry flask, add a few pieces of fused calcium chloride and stopper. Let stand for about an hour, place the oil, after it has been dried by the calcium chloride in a small fractionating flask and distill, using a very tiny flame and a long condenser. The ethyl bromide will come over between the temperatures of 35° to 41° C. (95° to 106° F.), the true boiling point being 38.4° C. (101.1° F.).

There is another simple way of obtaining the halogen derivatives of the paraffins which consists in using red phosphorus and a halogen in its elemental state. Ethyl iodide is conveniently prepared in this way. Two grams of red phosphorus are placed in a 200 c.c. flask and 14 c.c. of absolute alcohol added Then gradually using a few crystals at a time, add 17 gr. of iodine, shaking and cooling the mixture as the reaction takes place. As the iodine is added, it reacts with the phosphorus producing an iodide of phosphorus. This immediately reacts with the alcohol producing ethyl iodide. The mixture is now permitted to stand over night so that the reaction may be as complete as possible. The products chiefly consist of phosphorous acid and ethyl iodide.

To make the reaction as complete as possible, the flask is provided with a reflux condenser and then heated to the boiling point for half an hour. Cool and attach the condenser in such a way that the ethyl iodide may be distilled over. The distillation is continued until no drops come over. Keep the flame in motion, for otherwise the mixture in the flask will bump violently. Wash the distillate, which is colored brown by the iodine, with water to remove any alcohol which might still be present, and then wash with water to which a few drops of sodium hydroxide solution have been added. Repeat this last process two or three times or until it is colorless. Do not use too much caustic soda solution at one time, for an emulsion may be formed which breaks up with difficulty. The colorless oily ethyl iodide is placed in a small dry flask and calcium chloride added to dry the liquid. Let stand a few hours and then re-distill.

Atmospheric Nitrogen

By Gordon E. Mestler

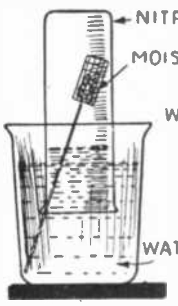


FIG. 1·

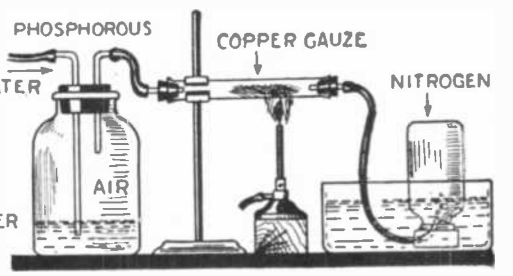


FIG. 2

Fig. 1. A simple method of making nitrogen from the air by exposing moist phosphorus therein. Fig. 2. Another method of preparing nitrogen from the air. The copper oxidizes at the expense of the oxygen of the air and "atmospheric" nitrogen is collected in the vessel on the right.

NITROGEN is not only found in the air, of which it is nearly four-fifths the volume, but is also found in nature in combination. Potassium nitrate is formed in nature by the action of bacteria on animal matter, and sodium nitrate is found in immense deposits in Peru and Chile.

Nitrogen may be easily prepared in three ways: by the oxidation of moist phosphorus in an enclosed specimen of air; by passing air over heated copper, and by passing ammonia gas over heated cupric oxide. The last way produces *pure* nitrogen while the first two are impure as they contain about one per cent. of the "inert" gases of the air.

To obtain nitrogen from the air it is necessary to remove the oxygen, which is done by allowing pieces of moist phosphorus (Fig. 1) to oxidize slowly in an enclosed specimen of air The phosphorus oxides, the products of the oxidization of the phosphorus, dissolve in the water

Since the oxygen of the air combines readily with hot copper while nitrogen does not, it is easy to obtain nitrogen by this method. Set up the apparatus as shown in Fig. 2. The hard-glass tube contains copper gauze or clean copper turnings. The air is obtained by letting water from the tap fill the bottle.

Heat the copper gently at first by moving the flame along the tube and then strongly. Do not burn the stopper. Carefully turn the water on so as to expel the air *slowly* from the bottle passing over the hot copper. Collect as many bottles of gas needed.

By using copper and magnesium in a longer hard-glass tube (30 cm. long), it is possible to absorb both the oxygen and the nitrogen of air. Put a loose plug of shredded asbestos in the middle of the tube with copper gauze on the left side and magnesium on the right. Heat both metals as shown in Fig. 3 and then very slowly pass a steady stream of air through the tube from left to right Continue as long as there is evidence of a change in both metals.

Pure nitrogen may be obtained by passing ammonia gas over heated cupric oxide (Fig. 4) and the water removed by bubbling the gas through sulphuric acid.

When absorbing both the oxygen and the nitrogen, the products left in the tube are copper oxide (the powder on the copper gauze) and megnesium nitride

Nitrogen can also be made in the wet way by heating a solution of ammonium chloride and ammonium nitrite together. In this process it can be readily produced in large quantities without the annoyance of having to use ignition. Yet there is a superstitious feeling, as it may be termed, that nitrogen and chlorine are disagreeable neighbors, for nitrogen chloride is one of the worst explosives known, and of all explosives practically the easiest to detonate. If the chlorine should combine with the nitrogen, forming nitrogen chloride, things will happen, as the boys say.

The surprising thing in the history of nitrogen is that for so many years it was supposed to exist in air as such, without any admixture except, of course, carbon dioxide and that in very slight amount. It was only when a difference in the specific gravity of nitrogen prepared in different ways was found, that suspicion began to be excited that there was another element in air and one of the monumental discoveries of modern chemistry, that of the element argon, was made.

It is told of Georges Claude, the greatest living exponent of the liquefaction of gases, that he gave the rare gases from enormous quantities of air, which gases had taken many days to accumulate in his apparatus, to one of the great investigators. Such gases separate from air as does the nitrogen, when air is treated for liquefaction of its oxygen or for separation of the same.

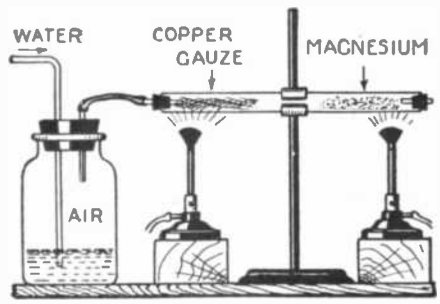


FIG. 3

Fig. 3. This is a most interesting variation on the preceding experiment. Here air is passed over ignited copper gauze and then over ignited magnesium, both as finely divided as may be. Plenty of copper must be used, so that no oxygen will reach the magnesium. The gas which then is atmospheric nitrogen passes over the ignited magnesium and this absorbs the nitrogen, forming magnesium nitride, and a little less than 1 per cent. of the original volume of the air issues, principally as argon, but also containing neon, carbon dioxide possibly, and a few other gases. There may be a trace of hydrogen from the water.

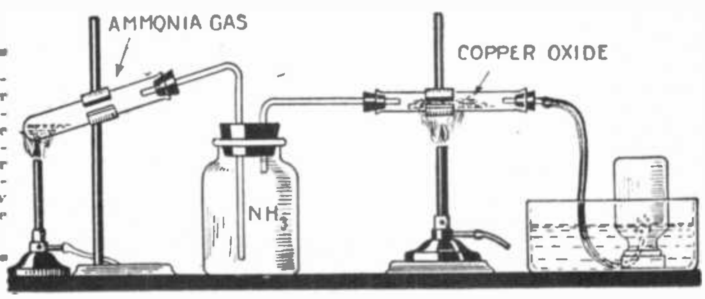


FIG. 4.

Fig. 4. By passing ammoniacal gas over copper oxide the latter is reduced to metallic copper, the hydrogen of the ammoniacal gas forms water therewith, and if everything is right, chemically pure nitrogen gas will be produced.

Preparation and Properties of Hydrogen Peroxide

By Eugene W. Blank

HYDROGEN peroxide, commonly known as "peroxide," is probably familiar to every one in the form of a dilute solution sold in the drug stores. This solution contains about 3% of hydrogen peroxide and is used for treating cuts and wounds. Pure hydrogen peroxide, however, is a compound possessing many peculiar properties and subject to many curious reactions.

Pure hydrogen peroxide is a colorless liquid with a bluish tinge when viewed in large quantities. It has no odor, but has a metallic taste. It is fairly stable at ordinary temperatures, but when heated under atmospheric pressure undergoes decomposition. This decomposition may at some times become so rapid as to cause an explosion, and it is no uncommon occurance to have a bottle of the compound explode. The pure substance is soluble in water in all proportions and this dilute solution is fairly stable.

The determination of the formula of hydrogen peroxide has caused some trouble due to its unstable condition, but the generally accepted value is H_2O_2.

Hydrogen peroxide is formed when oxygen is allowed to bubble about the electrode from which hydrogen is being liberated in the electrolysis of water. Hydrogen peroxide can also be detected in water on which some ether has been floated and ignited, and when a jet of burning hydrogen is allowed to strike the surface of ice water a small quantity of peroxide is formed.

The compound can be made in larger quantities by treating a cold concentrated solution of sodium peroxide with hydrochloric acid but in this method the product is always associated with a salt of the acid. By the treatment of a cold solution of potassium peroxide with tartaric acid peroxide is formed in a rather pure condition since the potassium tartrate is only slightly soluble in cold water and separates.

Hydrogen peroxide is usually made by the action of some acid, such as hydrochloric or sulphuric acids, on barium peroxide. When sulphuric acid is used barium sulphate is the salt formed, and since this is insoluble it can be filtered off and a rather pure solution of hydrogen peroxide will result. The reaction can be expressed as follows:

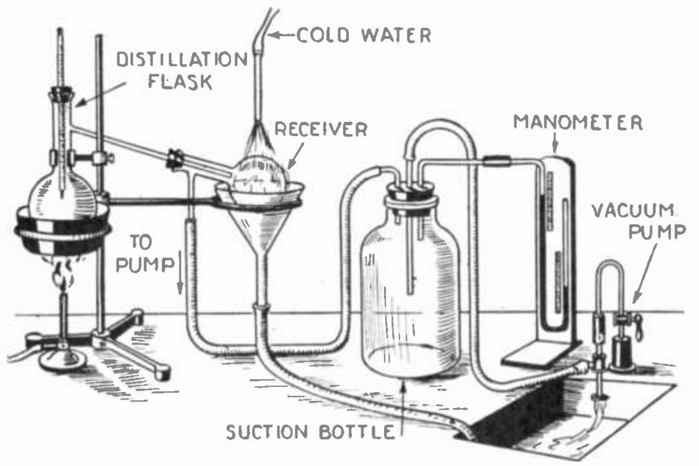
Barium peroxide + sulphuric acid —> barium sulphate + hydrogen peroxide

$BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$

To prepare peroxide make a paste of barium peroxide with water. Slowly add it to a mixture of equal volumes of water and sulphuric acid. Keep the temperature as low as possible by packing ice or placing cold water around the beaker containing the acid and water. Barium sulphate will be precipitated and this should be filtered off. Place the filtrate in a clean, evaporating dish and evaporate over a low flame until the liquid starts to decompose. This point is indicated by signs of effervescence. The liquid should be cooled immediately because concentrated solution readily decomposes when heated. The liquid contains about 40 per cent. of hydrogen peroxide and can be used for the following experiments:

For 169 parts by weight of barium peroxide use 98 parts of sulphuric acid. This refers to pure acid before you have added the water.

If the experimenter possesses the necessary apparatus, he can still further concentrate the solution by distillation under reduced pressure. To accomplish this, arrange the apparatus as the diagram shows. The solution is placed in a distilling flask connected with a receiver and having a thermometer placed in its neck. The side neck of the receiver is connected with a manometer and this in turn is connected with a water pump. The manometer and the filter pump are the only pieces of apparatus the average experimenter does not own, but can be purchased very cheaply. The flask is heated by means of a water bath, and when the temperature is about 35° C. (95° F.) and the manometer shows a pressure of 15 mm., an aqueous solution of hydrogen peroxide will distill into the receiver. Keep on heating the flask until the temperature rises to about 70 degrees C. Then stop the distillation because at 80 degrees C. the hydrogen peroxide would start to attack the glass of the flask. A very concentrated solution of peroxide is found in the distilling flask.



This apparatus is arranged to distil hydrogen peroxide in vacuum. The receiver is kept cool by a stream of water so as to act as condenser also. Note that the tube or outlet of the distilling flask passes the suction tube on the neck of the flask.

Pure hydrogen peroxide is decomposed very rapidly when finely divided metals are allowed to come in contact with it. Place some of the prepared peroxide in a beaker and drop into it some platinum black or some of the finely powdered metal. If platinum is not on hand, try powdered gold, silver or magnesium. In all these cases the metal is found at the end of the reaction in its original form and hence the action is catalytic. A catalytic agent is a substance that promotes a reaction without itself undergoing any change.

Manganese dioxide also causes hydrogen peroxide to break down with the production of oxygen and this reaction can be used for preparing oxygen on an experimental scale.

To prepare oxygen from peroxide place some manganese dioxide in the bottom of a flask and stopper it with a stopper carrying a delivery tube and a dropping funnel. Arrange to collect the evolved gas over water, and then having filled the funnel with hydrogen peroxide, allow it to drop slowly into the flask. The manganese dioxide acts as a catalytic agent and the peroxide is decomposed. When the reaction is over, test the gas in the bottles by inserting a glowing splinter. It will burst into a brilliant flame.

Mix some magnesium powder with a trace of manganese dioxide and place a few drops of the strong peroxide upon it. In many cases it bursts into flame.

Peroxide is a powerful oxidizing agent liberating iodine from solutions of the iodide and turning black lead sulphide into white lead sulphate.

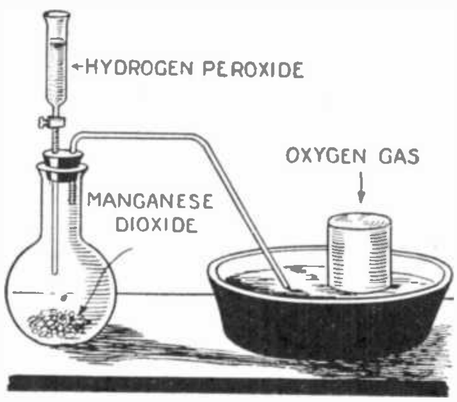
To some potassium iodide solution add hydrogen peroxide; the solution takes on a brown color due to the liberated iodine.

Prepare some lead sulphide by allowing hydrogen sulphide to bubble through a solution of lead nitrate. A black precipitate will be produced. Now add some peroxide and shake. The lead sulphide is oxidized to lead sulphate which has a white color. The above reaction is used in the cleaning of old paintings. These paintings usually have been darkened by the action of atmospheric hydrogen sulphide upon the lead in the paint. The peroxide will convert the lead sulphide into the white lead sulphate, clearing up the picture. Peroxide will also bleach indigo and litmus solution.

Hydrogen peroxide is also an important reducing agent. Lead dioxide formed by heating red lead with nitric acid dissolves very slowly, but if a few drops of peroxide are added, the lead dioxide is reduced to lead monoxide and this readily dissolves in the acid.

Place some potassium permanganate in a beaker and add a small quantity of sulphuric acid. The solution now has a dark red appearance, and if some peroxide is added, the red color disappears, the permanganate being reduced.

As an added example of its strong oxidizing power allow some sulphur dioxide gas to bubble through some water in a test tube. The sulphur dioxide gas can be prepared by allowing sulphuric acid to drop upon some sodium bisulphite in a generating flask. When the gas is allowed to bubble through water, a solution of sulphurus acid is obtained. Now when peroxide is added to the mixture of gas and water, the sulphurus acid is oxidized to sulphuric acid, and this will give a precipitate with barium chlorine solution.



Evolution of oxygen gas from hydrogen peroxide by the action of manganese dioxide on it.

There are two qualitative tests which are readily applied to a sample suspected of containing hydrogen peroxide. Place some titanium sulphate solution in a test tube and slowly add some peroxide. A beautiful orange coloration will appear.

With chromic acid peroxide forms a blue solution very soluble in ether. This reaction is used in a test for the substance. To

(Continued on page 706)

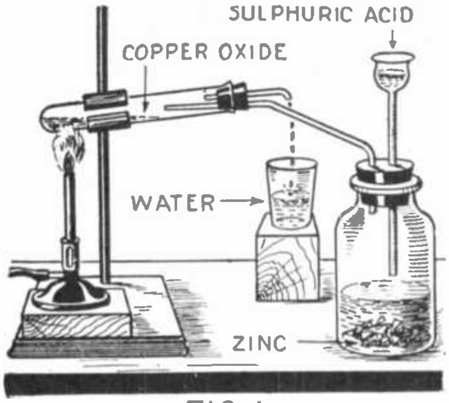


FIG. I

Copper oxide contained in a tube is ignited; hydrogen gas is passed into the tube and combining with the oxygen of the copper oxide produces water. The thistle tube must dip into the liquid in the generating flask.

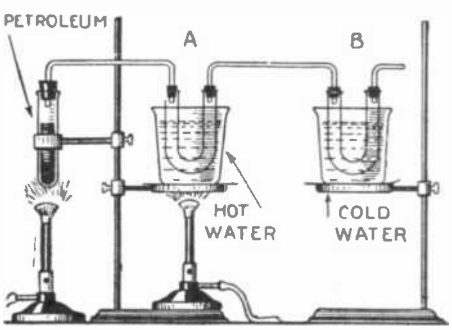
Fractioning Petroleum

THIS is a simple method of breaking up or separating the components of petroleum. We will need three or more ring stands, two rings to each stand, four or five U-tubes and beakers, glass tubing bent as shown and two Bunsen burners.

Partly fill a test tube with petroleum and attach two U-tubes as shown. Let the first U-tube rest in a beaker of boiling water, and the second U-tube in a beaker of cold water. Heat the petroleum gently and observe the vapors rising from it and passing into the U-tubes A and B.

The components of petroleum, which have a low boiling point, are driven through A and into B where they are condensed. When the petroleum is heated more strongly, components which have a high boiling point are driven off as vapors and condense in A. Although the temperature of A is high, it is still low enough to condense a fraction of the vapors. If we then pour the contents of A and B into evaporating dishes and examine them, we are reminded of gasoline, kerosene and benzene. We may separate them by adding more U-tubes and distilling more petroleum. The most remote would contain gasoline; the next naphtha; the next benzene; the next kerosene, and so on.

Contributed by Gordon E. Mestler.



Distillation of petroleum with fractional condensation of the distillate. This apparatus is applicable to other purposes where fractioning is desired. A whole succession of beakers at different temperatures may be made to condense a series of products.

This experiment does not by any means illustrate the manufacturing processes applied to petroleum. The most characteristic feature of such process carried out in the great factories is what is known as cracking. By exposing the vapors evolved from heated petroleum to more heat, they are decomposed, giving a quantity of lighter products and a corresponding quantity of heavier products. It will be seen that in this way a control is exercised over the process and according to the market more or less gasoline, more or less kerosene and so on will be produced. The market will control the manufacturer's process.

Reduction of Copper Oxide

By PAUL WALKER

COPPER oxide may be readily reduced by any of the following methods:

(a) Reduction of hydrogen. This consists of passing hydrogen over hot copper oxide. The hydrogen combines with the oxygen and water is formed, while metallic copper is left in the tube. Fig. 1 shows a simple method for doing this.

(b) Reduction by carbon monoxide. The reducing action of carbon monoxide may be shown by the following experiment. Carbon monoxide is prepared by the action of warm concentrated sulphuric acid on formic acid. The sulphuric acid causes the decomposition of the formic acid into water and carbon monoxide. The carbon monoxide is then passed over hot copper oxide. The carbon monoxide is oxidized to carbon dioxide and the metallic copper remains. The presence of carbon dioxide may be shown by using

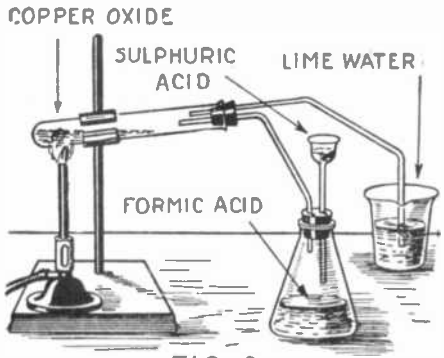


FIG. 2

An organic acid evolved in the gaseous state is acted on by the ignited copper oxide with the production of carbon dioxide gas as well as of water.

a bottle of limewater, as shown in the illustration, into which the escaping gas is passed.

(c) Reduction by carbon. A mixture of copper oxide and charcoal is heated in a test tube. The gas evolved is passed through lime water as above. The white precipitate shows the presence of carbon dioxide. Metallic copper is left in the tube.

The experiments described may be easily performed by the novice and offer some interesting entertainment. Pieces of metal may be copper plated in the same manner. Just sprinkle the copper oxide on the object to be plated and proceed as described above.

Sympathetic Ink

By SIMON LIEBOWITZ

HOW often have you longed for a really mysterious thrill! To have written upon an apparently blank sheet of paper a gold mine of information that cannot be read by anyone but yourself! Well, here it is.

A good sympathetic ink may be made by diluting sulphuric acid in water. The pen is dipped into the liquid and a message is written on a clean sheet of paper. The paper is allowed to dry, after which no trace of the original writing will be noted. To make the message appear, it is only necessary to heat the paper over a flame or to iron it (taking care not to burn the paper). Thus one need not fear of his close secrets being on the tongues of all.

This is the explanation for the above phenomena: Paper is cellulose, having a chemical formula of $C_6H_{10}O_5$. Sulphuric acid has marked affinity for water. In cellulose the proportions of water appear as $H_{10}O_5$. Upon heating the paper the acid combines with the $H_{10}O_5$ of the cellulose and precipitates the carbon. The original writing will, therefore, appear black, the natural color of carbon.

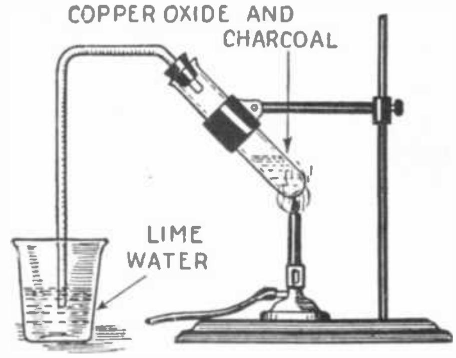


FIG. 3

Here the copper oxide is mixed intimately with charcoal and the two are ignited, producing carbon dioxide gas in considerable quantity. Without the copper oxide there would be no evolution of the gas except in trivial amount.

Hydrogen Filled Soap Bubbles

ARTHUR A. BLUMENFELD'S "Fun With Soap Bubbles" in the November, 1924, EXPERIMENTER called to mind an amusing experiment with soap bubbles, that, like Mr. Blumenfeld's experiment, also makes a very effective demonstration of the properties of a certain gas, in this case hydrogen.

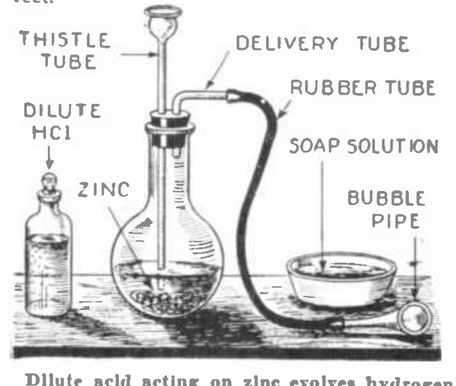
The following apparatus and materials are necessary for performing the experiment: (1) a hydrogen generator, (2) a piece of rubber tubing two or three feet long, (3) a pipe for blowing soap bubbles, (4) some granulated zinc or a few other small pieces, (5) a little sulphuric and (6) a strong solution of soap.

The generator may be constructed by placing a two-holed stopper in the mouth of a flask or bottle and inserting a delivery tube in one hole and a thistle tube or funnel in the other. The thistle tube should extend nearly to the bottom of the flask, while the delivery tube extends just barely through the stopper. The stem of the pipe is connected to the delivery tube by means of the rubber tubing and the apparatus is then complete.

Now place the zinc in the generator and pour enough dilute sulphuric acid down through the thistle tube to cover the zinc well. Hydrogen will be evolved and will pass out of the generator and through the pipe. When the action is well started, try blowing a bubble. Just dip the pipe into the soap solution and then let the hydrogen do the blowing. If the gas is coming too fast, pour a little water down the thistle tube; if too slow, add more acid.

When a bubble is blown, flip it off the pipe and, unlike ordinary bubbles, it will rise to the ceiling, or, if out of doors, float upwards until it bursts. Approach a bubble with a flame. When the flame touches the bubble, the hydrogen will ignite with a flash and the bubble explodes.

CAUTION: Keep the flame a good distance away from the generating apparatus and do not light the bubbles until they are off the pipe and have floated away several feet.



Dilute acid acting on zinc evolves hydrogen with which soap bubbles are blown.

Constant Speed Motor

By E. S. Nokes

THE small series-motor, either A.C. or D.C. run direct from the lighting circuit, is one of the most useful pieces of apparatus in the experimenter's laboratory. The difficulty of maintaining a constant speed, and the variation of speed, independent of load, is a drawback in many instances.

The governor here described will maintain any speed within the limits for which it is adjusted, and will maintain a constant speed independent of variation of voltage or load. By means of the two adjusting screws, a wide range of speed is obtainable, thus often saving the trouble of changing gear ratios on apparatus in use.

Fig. 1 represents the motor with speed device complete mounted on a hard-wood base; the governor is shown partly in section. (A)—is the motor, (B)—the usual sheave wheel, C—is preferably a turned metal disc or, if facilities are not at hand for turning this, a piece of cold rolled steel ¼ x 1¼ x 3 inches will answer the purpose, but care should be taken when screwing this to the sheave wheel, to locate it centrally, so as to ensure a good balance.

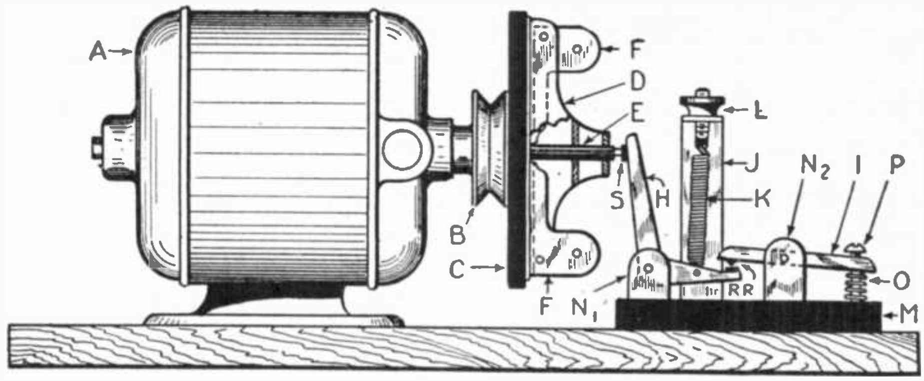


FIG. 1

An assembly view of the constant speed motor. The device here used, efficiently solves the problem of maintaining a constant speed in electric motors. The governor while maintaining any particular speed can be set by two adjusting screws for a wide range of control.

(D)—Fig 1 is the carrier for the centrifugal governor and thrust pin, and is shown partly in section. This is made of sheet brass .015-inch thick, cut to development

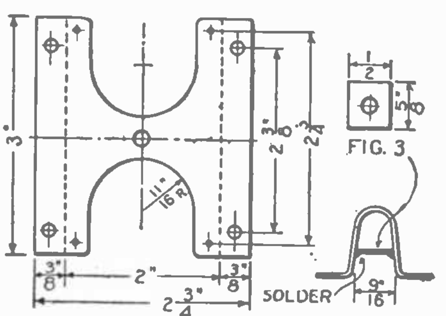


FIG. 2 FIG. 2-A

Details of the governing element to be used on a small constant speed motor. The construction is extremely simple and made of parts which all amateur experimenters will have on hand.

shown in Fig. 2 and Fig. 3, bent on dotted lines to shape shown at Fig. 2-A. Fig. 3 is then soldered in position shown at Fig. 2. It is best to drill all holes after bending. To locate center hole for push-pin screw carrier into position on disc (C)—Fig. 1, run the motor, and with a sharp pointed tool on a temporary rest, center the position of hole and drill 3/16 inch diameter, also drilling as shown in Fig. 3. This will ensure the push-pin (E) running true when motor is in operation. Push-pin (E) is made of 3/16-inch drill rod ⅞-inch long, drilled at one end, into which is inserted a piece of bakelite that projects ⅛-inch to insulate motor frame from lever (H)—Fig. 1.

(F-F) Fig. 1 are the governor weights and actuating arms; two of these are wanted, the arms are cut from the same stock as Fig. 2 to shape shown in development Fig. 4, bent on dotted lines to shape shown at 6 and 7. Fig. 4-A is a piece of 7/16-inch cold rolled steel ½-inch long riveted in position as shown, to form the governor. After drilling governor arms can be assembled as shown in Fig. 1, with pins (G-G); these pins should be cut from wire about .915-inch diameter with the ends turned over side of carrier (D), so that the arms swing freely with a little side play. When assembled push-pin (E) should rest on the ends of the two arms (F-F) and is pressed forward when weights swing outwards.

H—Fig. 1 is a bell-crank lever cut from the same stock as (D) to shape of development shown in Fig. 5, bent on dotted lines, soldered along the two bottom edges, and holes drilled. (I)—Fig. 1 is a small lever cut from the same stock to development shown in Fig. 6, bent on dotted lines and drilled.

(N-1) and (N-2) are two pieces of ½ x 3/32-inch brass rod bent to U—section and drilled to form bearings for levers (H) and (I), these are assembled to swing freely, and (N-1) and (N-2) are screwed firmly to bakelite block (M) in position shown in Fig. 1.

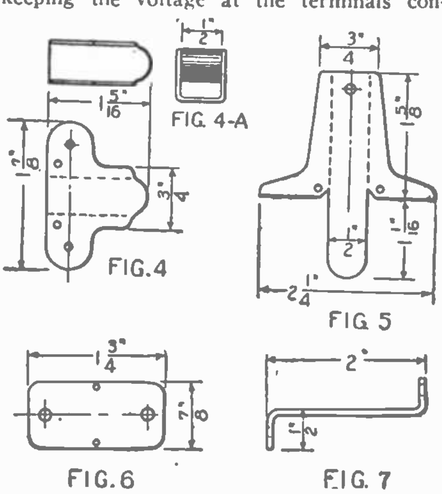
(J)—Fig. 1 is also made of ½ x 3/32-inch brass rod bent as shown in Fig. 7 and screwed to block (M) in position to carry spring (K) with adjusting screw (L); the other end of spring (K) is attached to lever (H). (O) is a small compression spring and (P) is a 10/32-inch screw tapped into block (M) with large clearance hole through lever (I).

(R-R) are contact points riveted to levers (H) and (I). This is a make and break and should be of tungsten or a like suitable material. (S) is a piece of ¼-inch diameter drill rod riveted to lever (H). It is best to slightly cup the end where it comes into contact with bakelite tip in end of push pin (E).

The wiring is simple, one conductor going direct to one pole of motor, the other is connected to (N-2) and the other pole of motor to (N-1).

The operation is as follows: When the motor is started the centrifugal governor pushes out pin (E) actuating lever (H) by overcoming resistance of spring (K). The lever (I) follows the motion of lever (H) owing to action of spring (O) until stopped by coming in contact with head of screw (P). Lever (H) still traveling breaks contact (R-R) and the speed of motor is arrested until contact is again made. As will be readily seen by adjusting screws (L) and (P) wide ranges of speed con be obtained. The make and break is very rapid, causing the motor to maintain a constant speed.

The speed of direct current motors may be varied electrically in two ways: First by varying the potential impressed at the armature terminals, the field strength remaining constant, because the speed of a direct current motor operating at constant field will be directly proportional to the voltage impressed on its armature terminals; second, by varying the field strength, but keeping the voltage at the terminals con-



Additional details of the brass parts of the governor on the constant speed motor. The parts are made of very thin sheet brass and can be cut to shape without difficulty.

stant. The speed of a motor whose armature potential remains unchanged will be inversely proportional to the field strength. Speed control can also be obtained by a combination of the two methods just mentioned.

These are electrical methods of speed variation. In the governor described in this article, a mechanical means is provided for speed variations.

A Hot Wire Ammeter

By N. Combi

THERE are many uses to which an ammeter can be put. And for those who are not willing to spend the money to buy the real thing, the instrument described here will work as a fairly good sub-

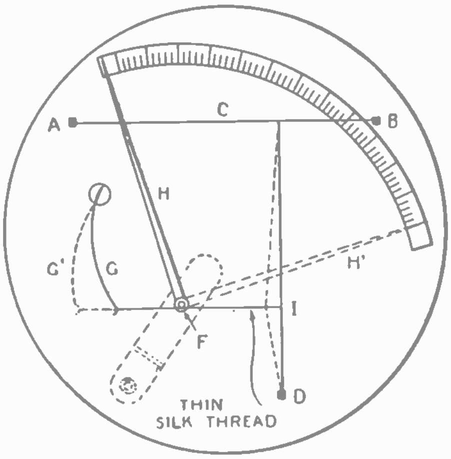


FIG. I

The diagram shows the wiring circuit of a hot wire ammeter. To the measuring wire, C, is attached a second thread or fine wire; a thread attached near its center is wound around the shaft of the pointer, and is secured to a spring beyond it.

stitute. The hot wire type was selected not only on account of its being simple to construct, but also for the reason that it will read direct currents as well as alternating currents of any frequency on the same calibration.

The action of the meter is as follows: The measuring wire (C) is stretched between two brass blocks (C) and (B) which also form the terminals of the instrument attached to (C) at a point a little away from the center, is a thin wire which is stretched tight and fastened to another block (D). To this wire again, a little away from its center, is fastened a piece of thin silk thread which, after being passed once around the spindle (F) is fastened to a spring at (G) The spindle (F) carries a light pointer.

In action, when a current is passed through the wire from (A) to (B) or (B) to (A) it heats up the wire and allows it to sag a small amount as shown by the dotted line. This permits the second wire from (C) to (D) to sag also, but to a greater extent, and the spring (F) in taking up the slack of the thread assumes the position (G) and in doing so turns the

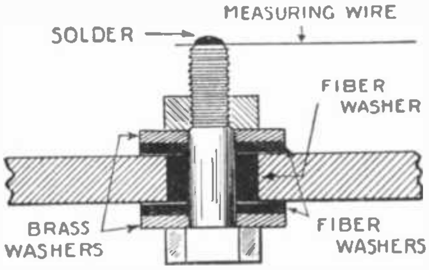


FIG. 2

The method of mounting the measuring wire of the hot wire instrument. Its ends are soldered to the terminals of the instrument.

spindle and moves the pointer over the scale.

The first consideration in making this instrument is the section and length of the measuring wire (C). The length should be about 2½ inches, and its diameter or section will depend upon the desired range or amperage to be measured, and the material of which the wire is made; the lower the amperage, the greater the resistance is the rule. For a very low range, say from 0 to 5 ampere, use No. 40 iron or resistance wire, while for anything having a maxmum range of one ampere or more, use copper wire of a size to be best determined by experiment; No. 40 copper wire would give a range of from 0 to 1.5 amperes.

The most important point to note is that the base upon which the instrument is mounted should be of the same material as the measuring wire, otherwise the expansion of the wire due to the temperature changes of the atmosphere will completely throw the readings out, and you may perhaps have a very successful thermometer, but not an ammeter. For this reason it is advisable to use iron or copper for the measuring wire, because it is easy to procure solid plates of these materials, while if a wire made of alloy is used, the base plate would have to be of the same alloy which might not be easy to get. I found, however, that many of the resistance wires on the market these days have a large percentage of iron in them, and if such wire is used in conjunction with an iron base plate, the difference in the coefficient of expansion between the plate and the alloy wire may not be too much. The actual wire I used in my instrument was No. 38 "Concodine" which, when mounted on iron, was hardly affected by changes of atmospheric temperature and gave a range of 0 to .4 ampere. Whatever you do, do not use wood as a mounting. This is practically unaffected by the temperature, but it warps a great deal in damp weather.

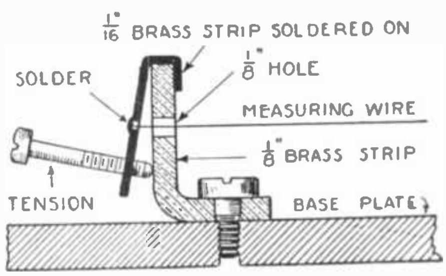


FIG. 3

One end of the measuring wire is provided with a tension adjustment device which is illustrated above. By means of the adjustment screw, the pointer can be set to zero at the start of the measurement.

Resistance wires may be tested to see if there is iron in them by means of a magnet.

The next step is to prepare the base plate which should be about 3 inches in diameter and ⅛-inch thick. At the position (A) in Fig. 1 drill a ¼-inch hole, into which is fitted a ⅛-inch bolt and nut. The end of this bolt projects about 1/16-inch above the face of the nut (which should not be more than ⅛-inch thick) on the inside of the base plate. This bolt forms one of the terminals of the meter and has one end of the measuring wire soldered to it. It should be well insulated from the base plate as shown in Fig. 2 in which three fibre washers and two brass washers are used.

Fig. 3 shows the method of fixing the other end of the measuring wire at (B) in Fig. 1 with a means of adjusting its tension.

At (D) in Fig. 1 another brass screw will be required. This should be screwed into the base plate with its end projecting above the level of the plate and provides a place for securing the other end of the wire (C) (D). This wire should be drawn to a moderate tension and soldered to (D). The whole system of wires of silk thread should be kept about 1/16-inch above the base.

And now for the spindle and pointer. The pointer may be made of anything light, a thin strip of paper shellacked for stiffness being about the best and easiest to make. As for the spindle, the balance wheel of an old table clock would be just the thing, but if this cannot be had, a piece of iron wire (about No. 18) one inch long should be carefully filed to a round point at both ends and mounted as shown in Fig. 4. The control spring (G) consists of a piece of steel wire out of an old motor cycle "Bowden" wire or a piece of main spring from a very small watch. This should be secured to the bolt "x" in Fig. 5 in the slot cut for the purpose.

In assembling the instrument (referring to Fig. 1), first fix up the two supporting blocks (A) and (B). loosen the adjusting screw at (B) completely and solder the measuring wire tight across the two points (A) and (B). Now attach the wire

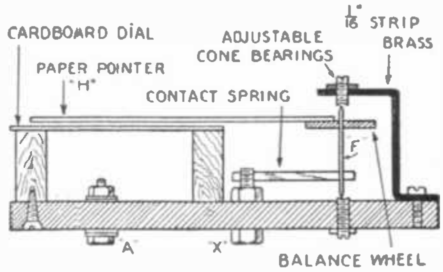


FIG. 4

A sectional view of the hot wire ammeter showing the method of mounting the dial. The pointer is made of paper and attached to a balance wheel from a discarded clock, whose shaft pivots on point bearings.

(C) (D) which should be the thinnest possible copper to the measuring wire at the point (C) draw it up moderately tight and solder the other end to (D). Next place the spindle (F) and spring (G) in position, and fastening one end of a thin silk thread to the wire (C) (D) at the point (I), pass it once around the bottom of spindle (F) and secure the other end to the end of spring (G). See that the spring is adjusted so that it will just take up all the slack necessary to carry the pointer completely across the scale.

The instrument is now ready, and all that remains to be done is to fix a cardboard scale atop the three wooden blocks (two of which are shown in Fig. 4), set your pointer at zero and calibrate by comparison with a

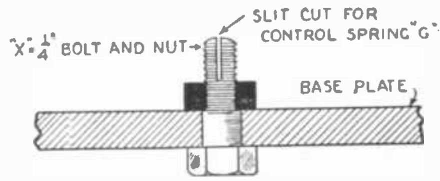


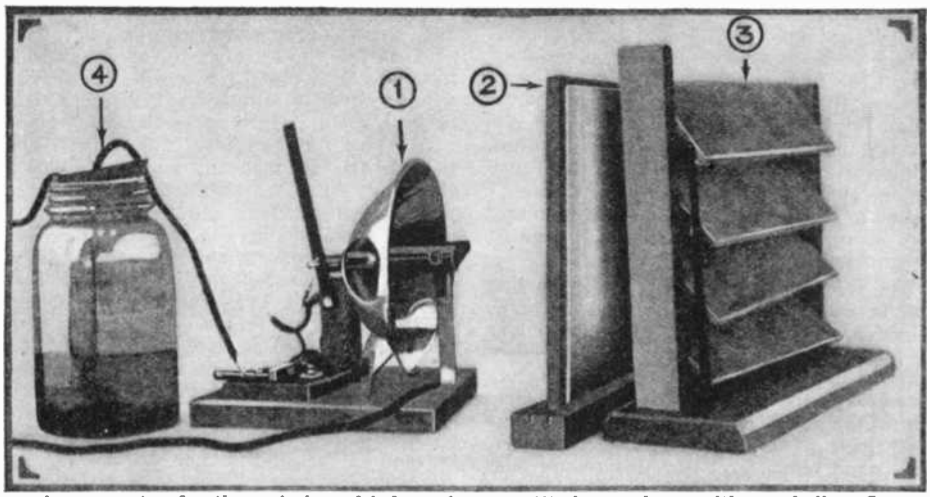
FIG. 5

The figure shows a slotted screw passed through the base of the hot wire instrument to hold a control spring which maintains the tension of the hot wire system.

standard instrument. If at any time after calibration the pointer does not stand naturally at zero, it may be set to its proper position by adjusting the tension of the measuring wire.

Experiments with Infra-Red Rays

By W. A. Sperry



An apparatus for the emission of infra-red rays. (1) An arc lamp with parabolic reflector. (2) A filter for cutting off light waves without obstructing heat waves. It is a solution of iodine in carbon disulphide contained in a glass tank. (3) A set of shutters to regulate the heat waves. (4) A water rheostat used in connection with the arc light.

INFRA-RED rays, like visible radiations, can be reflected and refracted, diffused, absorbed and polarized, but they differ from the light rays of the visible spectrum in that they stimulate no highly specialized human nerve endings, save those few scattered and undeveloped ones, responsive to temperature changes; although the brilliant new theory of M. Henry, demonstrating mathematically that taste and smell are functions of specific infra-red wave-lengths, will probably modify this somewhat.

Among the more important applications of heat waves are the invisible signaling systems as developed and standardized by the French army and the distant control of independent, dynamic mechanisms. The first experiments to be described are along the lines noted above, namely, telegraphy and teledynamic control. In addition to this, telephonic communication and the advisability of designing some sort of "tuning" system has to some extent been studied, both experimentally and theoretically.

Possibly one of the factors which prevents many experimenters from entering this field is their lack of equipment, and the absence of sufficient data concerning the building of the same. The preliminary experiments, in this case, were carried out with apparatus of extremely simple design, and as a result the expenses were correspondingly small, while the trouble prevalent with complex apparatus did not exist. In the beginning, it is necessary to have some means of generating infra-red radiations. The arc was chosen as the simplest, yet most powerful method, because of the fact that its temperature is the highest of any available source and is therefore richer in heat radiations. The possibility of control by direction (and hence, conserving) these rays is one of the great advantages incident to their use. Two methods or a combination of them, may be used for doing this; a silvered parabolic reflector, or a lens, or both, constitute a system for focusing these radiations into nearly rectilinear shafts of approximately parallel rays.

Here another advantage of the arc is manifest since its heat source is concentrated in the closest approach to a point of almost any type of generator. This makes the use of the parabolic reflector the most practical form of focusing device, not only because it is specially adapted to the point heat source —in fact, demands it—but also because having a polished surface of silver it will absorb approximately only 3 per cent. of the heat, reflecting the rest as radiant energy, while a glass lens will cause treble the above loss.

The arc in the apparatus to be described was built and equipped with a parabolic reflector of doubtful antecedents, but of nice proportions, and it has since been found that an automobile headlight will serve admirably as a reflector, and even as a virtually complete transmitter. Diagram A (1) shows the method of mounting the arc carbons, which allows for exact focusing and careful adjustment. Some authorities state that impregnating them with barium chloride tends to increase the radiation producing a flaming arc.

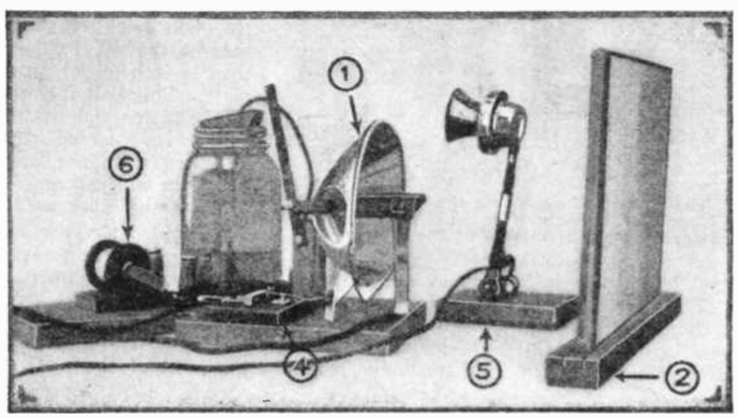
The arc was designed to operate a 110-volt A.C. supply, working through a resistance which consists only of a Mason jar (see photograph) filled with a weak salt solution, and fitted with a stationary plate at the bottom and a movable one operated from the top for adjustment. This allows the correct amount of current to pass, but—don't short the plates.

It is apparent that the combination of arc and reflector represent an ordinary searchlight, but if one objects to the visible rays being transmitted, there are many ways whereby these radiations may be cut off, leaving only the infra-red. The usual method involves the use of a screen of diathermanous material such as black (manganese dioxide) glass, black fluorite, colored gelatins or a strong solution of iodine in carbon disulphide. This latter was taken as the most easily obtained and a sort of tank, (A2), is built consisting primarily of two large photographic plates, 11 x 9 inches, from which the emulsion has been removed, a wooden frame, thoroughly paraffined, which separates the plates and in addition acts as the container's sides, bottom and top, plus a base to complete the arrangement. Into this tank is poured the solution, made by dissolving iodine crystals in carbon disulphide to the point of saturation. It is then tightly sealed with paraffin and a most effective diathermantic is the result. The transmitter as described is in use continually and can serve in any of the experiments discussed here with of course certain auxiliary apparatus.

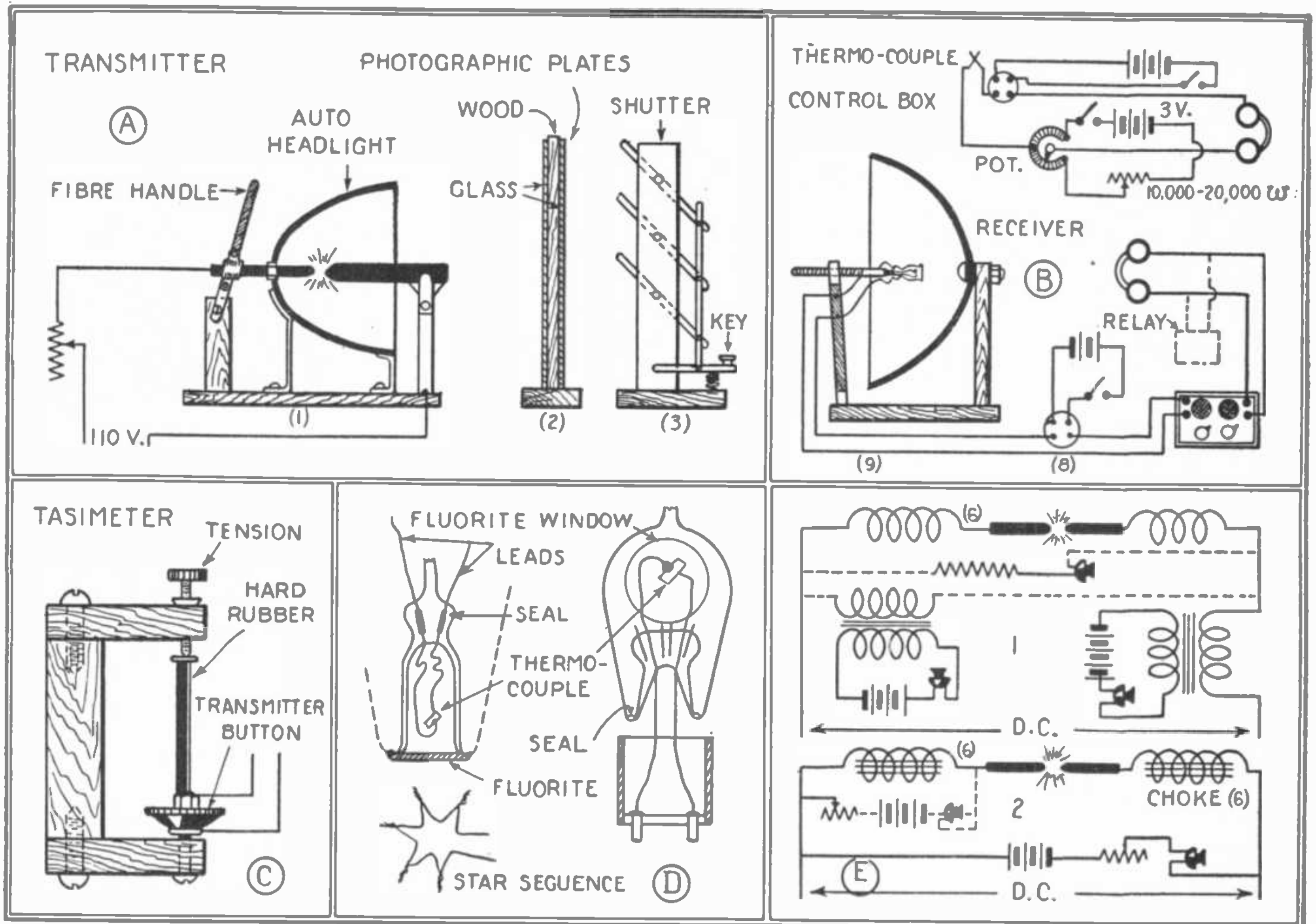
The next consideration should be the receiver. There are many possible detectors of radiant heat, yet only three are simple and efficient enough to warrant description. The best and most satisfactory reception is without doubt made with the aid of the thermocouple, although devices based upon expansion, both linear and volumetric, are employed with success. Of these the Edison tasimeter is an example. It is based on the principle that the linear expansion of vulcanite when heated produces corresponding changes in the current flowing through a microphone. The author has modified this idea by replacing the original carbon-block microphone with a transmitter button, by so doing increasing the sensitivity well nigh 300 per cent. A hard rubber or bakelite strip is used in place of the vulcanite rod. Both of the improvements serve to augment the speed of the instrument, though in any of its present forms it requires so much time to act that the lag is a great factor in the elimination of this device as a practical detector of infra-red disturbances. Used in connection with telephony on heat waves its sluggishness produces queer distortions and forbids its employment in this capacity. Various kinds of thermostats based on gaseous expansion have been arduously tested; the latter type "fills the bill" to a certain extent, but is difficult to construct and keep in order. As before stated, it is the writer's opinion that the thermocouple offers the easiest, quickest and best solution to this problem.

The theory of the thermopile resolves upon this proposition: the junction of two metals when heated produces an E.M.F. which may be detected by suitable instruments. The construction of such thermopiles involves the joining of dissimilar metals. This may be accomplished by soldering, twisting, riveting or welding—and I shall describe several thermocouples of proved design. The simplest type consists of two wires twisted together at one extremity and connected to an indicating instrument. Another form is the star sequence (see diagram) which is well adapted to this work.

Combinations of iron and constantine, or of silver and bismuth wire, work admirably as thermocouples, but the most efficient, most sensitive thermocouple has as its elements a plate of platinum and a crystal of tellurium. These are inclosed in an exhausted bulb to get rid of the effects of moisture, while a non-absorbing fluorite window allows the rays to reach the junction with undiminished energy. To Messrs. Herbert-



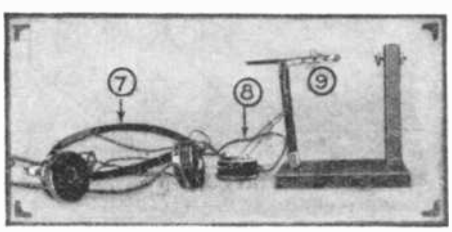
Infra-red light transmitting apparatus provided with a microphone (5) which impresses the speech modulations on the arc. A choke coil (6) is connected on both sides of the arc. The other numerals correspond with those on the other illustration.



Constructional and circuit diagrams of the infra-red transmitter and receiver. (A) transmitting apparatus. (B) receiving circuit. (C) tasimeter, a form of heat wave detector. (D) a thermocouple heat wave detector used in the infra-red receiver (E) two circuits for the infra-red transmitter.

Stevens and Larigoldie belongs the credit of the development of this detector, but the home-made imitation, whose description follows, even though it cannot approach, in point of sensitivity, that of these gentlemen, undoubtedly constitutes the very best that can be obtained with little effort and limited resources.

A discarded 60-watt lamp furnishes the wires, seal and tube for this couple, so all that remains is to weld a tiny square of heavy platinum foil to the end of one of the lead-in wires, and a crystal of tellurium to the other. The welding may be accomplished by using a pointed carbon electrode in series with the water resistance and the metal work; in short, a sort of spot-welding system is arranged. When the welding is complete, heat and seal the tellurium to the platinum, making the joint as minute as possible so as to dissipate any permanent heating effects. It is then an easy matter to crush down the ex-anchor wires in such a way as to draw the junction into the tube. The next step is the formation of the window, which is very simply done by sealing a polished flake of fluorite over the open end of the tube. The heat used in this operation will expel the air to some extent within the tube, but this will suffice. The



Showing the heat wave receiver mounted on the stand with the parabolic reflector removed. For diagram of connections refer to diagram (B) above.

diagram (D), 1 illustrates its construction and the photograph shows the unit mounted on bakelite strips by means of adhesive tape.

A more versatile form of this cell may be made by dissecting an old electron tube (which must be transparent) and utilizing the plate and grid leads for supports. Carefully break off the tip before putting in the fluorite window, then seal the glass foundation back into the bulb again and seal a bit of glass tubing to the aperture where the tip was formerly. The bulb is now ready to be pumped out. A high vacuum is unnecessary, but it is desirable to have considerable rarefaction since the radiant heat is thus conserved. If the base of the tube is restored, one has an exceedingly convenient unit, because it will fit any standard V.T. socket. The latter type of thermocouple is to be preferred, except that it is too large to be mounted in the focus of a *small* reflector. Either of these will, moreover, require the control box shown, to protect the delicate junction from varying external heat conditions in its environment. The potentiometer (200 to 300 ohms) and the three-volt battery make the balancing of the circuit easy. A high resistance is also needed; a variable grid leak will perform its function nicely.

The first experiment tried with this apparatus was an attempt to transmit intelligible signals. The outfit was connected as in (A) and (B) and was set up in the laboratory with transmitter and receiver only a few feet apart. This test showed conclusively that one-way communication could be satisfactorily demonstrated over a distance of fifteen feet *without* using amplification. Three hundred feet is quite easily traversed with an ordinary two-stage audio-frequency amplifier at the receiving end, while with a larger transmitter, a mile is by no means the maximum distance. When the arc has been focused, place the screen and shutter (A3) before same.

In the receiving hook-up a high frequency buzzer provided with an extra contact interrupts the thermoelectric current in order to give audibility. A tikker or similar device has given the best results, and is employed exclusively by the French. Phones may be connected directly in this circuit or in the output of an amplifier. If a sensitive galvanometer or relay is used, the chopper may be eliminated—by the way, a relay may be easily extemporized if one has a galvanometer, by merely placing an adjustable contact in proximity to the indicating arm. This will serve as a receiving relay in the control experiments. When the generator is in operation, the nearly parallel rays impinge upon the receiver and are reflected to a point on the thermocouple, which produces a unidirectional current broken by the buzzer chopper and finally an audible musical sound in the phones results, varying in intensity with the voltage, which in turn is proportional to the heat on the thermojunction.

Keeping these facts in mind it is easily seen that by impressing a speech-modulated current on the arc, variation of its temperature results, with like effects on the heat-detector. Needless to say, however, the interruptor must be cut out before telephony is attempted. It is also unnecessary to state that direct current, well filtered and smoothed, must be used on the arc. As to sources of D.C., 110-volt city "juice" or 32-volt farm lighting current is adequate, while rectified A.C. or "M.G.ed" D.C. also furnish possible ones. Several diagrams (E, 1 and 2) show methods for superimposing speech of the arc current. Telephony is carried on in the laboratory quite regularly, but the maximum range with this apparatus does not exceed seven hundred feet.

Experiments With Ford Coils

By Clyde E. Volkers

THERE is a certain attractiveness, a sort of irresistible charm, connected with the hum of a coil vibrator, and the crackling of the spark leaping across its gap.

Many an hour of idle toying have I spent before a spark or induction coil, wishing I might apply its interesting forces to advantage in some new, interesting experiment. In those days I had at my command only a very few of the possible ones. These were repeated day after day, year after year; at times a new one being added eagerly to the slowly growing list. Now I offer a few of the more interesting and instructive ones for the benefit of the other experimenters who may be passing through this same evolutionary state.

It is a simple matter to secure an induction coil in these days. An auto wreck has its advantages for the experimenter. Spark coils may be salvaged from the wreckage, and with a bit of doctoring, perhaps, will serve as well as new ones. Their cost will be only a few cents. The common Ford coil is very adaptable. If coils cannot be secured from a wreck or a wrecker, borrow one of the series of four from the car. It need not be harmed in the least.

If permanent experimental coils are secured, solder Fahnestock clips to the contact discs on the coil box. See Fig 1. The clips may be secured from discarded "B" batteries. If coils are borrowed temporarily, make the connections by winding the uninsulated ends of wires into spiral spring shape, holding them in contact with the discs by means of rubber bands cut from an old inner tube. See Fig. 2. You have not got away from the automobile yet.

The coil is connected in series with two or three dry cells and a telegraph key, push button, or any single pole switch, as shown in the diagram, Fig. 3. The wires leading from the discs on top of the box, the secondary "leads," are connected to a spark gap as shown. Any number of coils may be connected and led to one gap, increasing the length of the spark.

The spark gap is very simple in construction, consisting of two binding posts, each having holes for two wires, fastened to a small base cut from an old storage battery

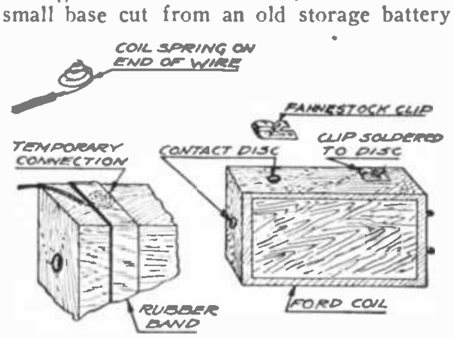


FIG 2 FIG 1

Showing the method of mounting terminals on the Ford spark coil.

jar. Common steel needles, or copper wires pointed at the ends, are inserted in the upper holes; the secondary "leads" are fastened in the lower holes, as indicated. Rubber erasers removed from lead pencils may be pushed over the eyes of the needles as shown. The binding posts should be tightened to the base to hold them firmly, but allowing a slight rotation or change in position, as desired for some experiments.

2. The Experiments

(1) Puncturing paper, leaves, thin glass, etc.

Start the coil vibrating and adjust the needles to secure a strong, regular spark. (Caution: adjust or touch only one needle at a time—never grasp one in each hand.) Insert a piece of paper in the line of the spark. The paper is punctured. Glass will also be pierced if a strong enough spark is produced. For small coils very thin glass should be used.

An interesting application of the paper experiment may be used to prepare "trick" cigarettes or cigars to offer friends. The cigarettes or cigars are held between the gaps permitting the binders, paper or tobacco leaf, to be punctured by a myriad of tiny holes, invisible to the naked eye, but thoroughly effective in rendering them unsmokable. No end of fun will result if a few of the "tricks" are placed in the package with the good smokes—being sure that the friends get the "doctored" ones.

(2) Increasing the length of the spark.

Place a drop of water on a piece of glass, allowing the spark to leap across it. Notice the distance the needle points may be separated.

A glass held in the steam arising from a tea kettle may be used to produce an interesting effect also. Other liquids and substances may be used in like manner to determine the good and poor conductors among them.

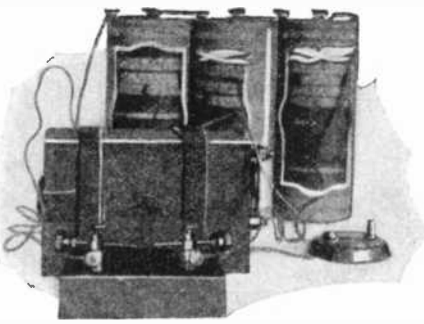
(3) Effect of a flame on the spark.

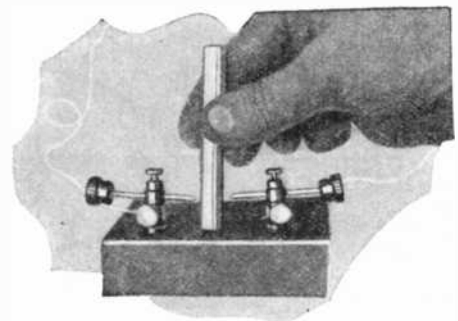
Introduce the flame of a Bunsen burner, candle or alcohol lamp near the spark. As it approaches within certain limits, the spark will be attracted to the flame, bending toward it in an arc outside of its usual path.

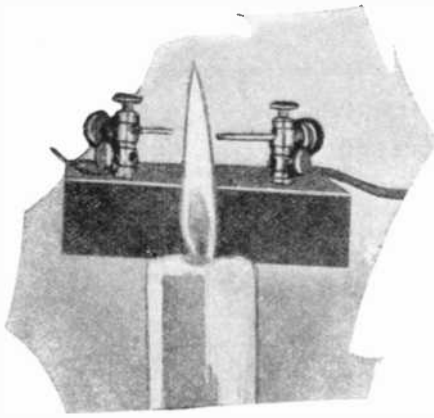
Now introduce the flame directly into the spark. The needles may be separated at a greater distance in the presence of the flame. Different action and effects result as the spark passes through the various parts of the flame; that through the lower part differing greatly from the effect produced when the spark passes through the upper part.

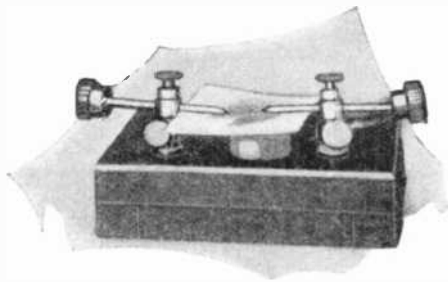
(4) Action of the spark on metal filings.

Mix some fine filings of copper and iron on the dry surface of a piece of glass. The spark causes the two metals to separate. Other substances and metals may be substituted for the copper and iron. The filings may be secured by rubbing a fine file









Some ingenious experiments with a spark coil, illustrating the effect of discharges through a flame, across metal filings and through thin cigarette paper.

over the surface of the metal, catching the fine dust on a piece of white paper.

(5) Combustion of a piece of metal.

Attach two pieces of very fine wire to the needle tips. Close the switch and adjust the needles to secure a hot, red spark. The wire on one of the needles burns as though it were some easily combustible material. The effect may be considerably increased if a small section of glass tube is slipped over the wires before the coil is operated.

(6) Passing the spark through various transparent and semi-transparent chemical crystals.

Drill a hole through various crystals, such as blue vitriol, potassium, ferroprussiate, alum, rock candy and others. When a spark is sent through the crystals, various effects will result. The means may be used in a simple way to determine, qualitatively, unknown crystals, if data is kept on the action of the spark with known ones.

(7) An electro-carbide cannon.

A safe, but noisy little cannon may be made from a Karo or molasses can; or any small tin container having the type of tight-fitting lid used in such cans. A spark plug is inserted in a hole cut in the can. Solder should be melted around the plug to make the connection air-tight. The can is to be fastened down to a heavy board; the end

(*Continued on page 703*)

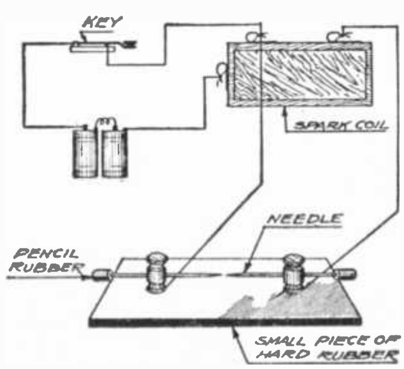


FIG 3

Diagram of connections for the Ford coil provided with a key in the primary and a needle gap in the secondary.

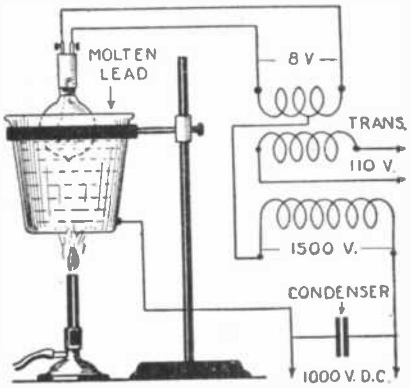
Lamp Bulb Rectifier

By Rudolph Sturm

FOR the benefit of other experimenters I will describe one of my most interesting rectifier experiments. I have constructed many different kinds and types of rectifiers, but this seems most original.

I have always endeavored to find a high voltage rectifier that would be efficient and quiet in operation. I constructed a synchronous rectifier which will rectify anything from 0 to 1200 volts, but did not suit my taste for quietness.

I have done considerable experimenting with thermionic rectifiers and worked the familiar double filament auto lamp very nicely, but these lamps (at least the makes I could obtain) contained some kind of inert gas, and therefore would ionize at about 90 volts; the limit was a load of about 30 milliamperes. Anything more



In this lamp-bulb rectifier a curious application of the Edison effect is made use of. An ordinary 8 v. incandescent lamp bulb is immersed in molten lead which forms the plate.

would cause the filament support wire (which was used as the plate) to become excessively hot. The output from this we see was 1.2 watts per tube, too small to charge even a small storage "B" battery effectively unless two or more tubes are used. Two, of course, can be connected in such a way as to utilize both halves of the A.C.

Then I experimented with the double filament 110-volt lamps, the one which goes under the name of "Hi-Lo." This worked very well as a rectifier by burning out the small filament and using its support as the plate of the tube. The base of the tube had to be taken off and all the connections brought out. This worked well up to about 300 volts. The wires in the seal of the tube were not separated far enough to permit higher voltages with safety. The current has to be limited to approximately 40 milliamperes. Its maximum safe output was, therefore, 12 watts per lamp.

I remember reading that hot glass becomes a conductor of electricity, but never tried it. Then my thought was to heat the glass of any ordinary lamp and put a conductor on the outside of it, so that connections could be made and used as the plate or anode of the tube. First I found by experiment that glass becomes a conductor long before it actually melts.

I then heated lead in a small ladle and just upon its melting I put an already heated small auto lamp half way into the molten metal. This lamp I knew contained no inert gas because it had a plain Mazda filament. The diagram shows clearly how this was done and the connections.

I drew 50 milliamperes D.C. with this arrangement upon which the voltage dropped to 800 (measured by my home-made and calibrated electrostatic voltmeter).

The tube did not act as a rectifier until the lead reached a temperature considerably above the melting point.

Besides showing without a doubt that hot glass is a conductor, this experiment filled the bill as to the voltage and current desired and quietness of operation. Anyone trying this experiment should be very careful with the high voltage as it might prove fatal if handled carelessly.

High-Tension Condenser

By Raymond B. Wailes

HERE is an adjustable condenser which will stand up under the output of spark coils up to one inch in spark length. The device will not stand up under radio transmitting transformers, etc.

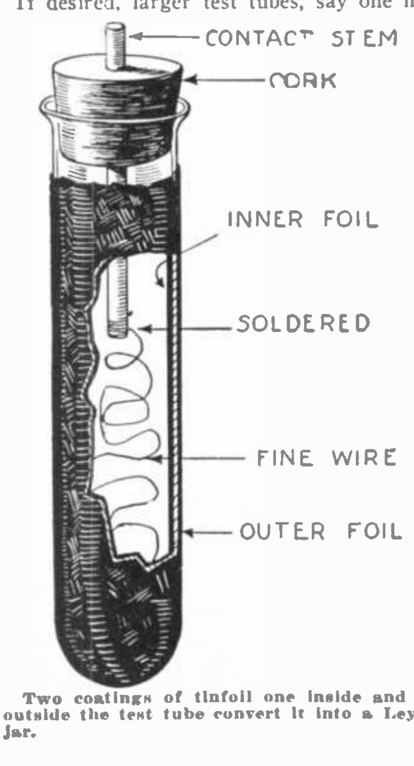
The instrument is based on the Leyden jar principle, test tubes serving as the jars and dielectric with tinfoil as the inner and outer coatings. One or the whole group of six test tube Leyden jars can be used as desired, individual capacities or tubes being taken out with ease.

The tubes used by the writer were the ordinary chemists' test tubes, and were 6 in. long and ¾ in. in diameter. The inside and the outside should be coated with a layer of tobacco foil or thin copper foil. A broken down condenser taken from the interior of a Ford spark coil is a good source of "tin" foil.

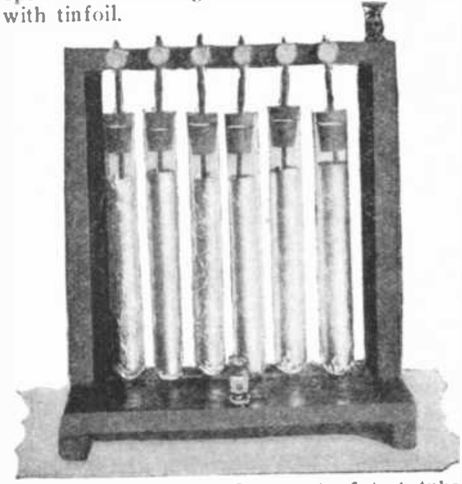
The stand is made of a size to suit the experimenter. A strip of copper runs across the base of the stand and also between the two uprights. This copper strip serves to make contact with the outer foil coating of the test tubes. All the outer coatings of foil are connected together by this means. The uprights carry a cross-bar member of wood to which are affixed six binding posts, large size, of the insert type These six binding posts are connected together by copper strip and an extra binding post is added as connection.

Corks, each one carrying a stiff four-inch length of copper or iron wire, are inserted into the test tubes. A length of flexible uninsulated wire is soldered to the interior ends of these stiff wires. These flexible uninsulated wires make contact with the interior tinfoil coating of the test tubes. It can be seen that the stiff wires passing through the corks can be raised or lowered through the holes in the insert type of binding posts mounted upon the cross strip, and at the same time readily permit the insertion or removal of any one or all Leyden tubes very easily. Contact with the inner coating is made at all times for the flexible wire soldered to the stiff wire is at certain points immovable, and always in contact with the inner coating.

If desired, larger test tubes, say one inch in diameter and ten inches long, can be used for the instrument. Again, the interior of the tubes can be filled with a table salt solution, the stiff wires being immersed in this liquid at their interior ends for contact. This will eliminate the seemingly tedious operation of coating the interior of the tubes with tinfoil.



Two coatings of tinfoil one inside and one outside the test tube convert it into a Leyden jar.



A convenient stand for a set of test tube Leyden jars. The tubes are removable and therefore the capacity of the set is made adjustable.

Reducing Charger Noises

THE "Tungar" rectifier, while efficient and convenient, sometimes becomes noisy due to the rapid vibrations of the metal case in the magnetic field of the transformer. Several ways were tried in hope of eliminating the hum. It could be reduced but not entirely prevented.

The metal container is removed; the bulb should first be taken out to prevent breaking it. The flexible wire and clip should be removed, care being taken not to break the wire protruding from the top of the bulb. There are two bolts that must be loosened that fasten the socket, then the four bolts on the back which hold the transformer, after which it can be taken from the case easily.

The charger may be set on a table or mounted on a panel with an ammeter and suitable switches. If mounted on a panel it should be secured by means of the four bolts and a brace to support the socket. After removing the case, and connecting it to a battery through an ammeter, I noticed that the charging rate had risen from 5 amps. to 7.5 amps. Upon further investigation I found that if the case was placed near the charger the amperage dropped, also other metals affected magnetically would cause the same thing.

The charging rate can be varied by removing the wing nut on the terminal board, just above the transformer, which is marked 105 V., 115 V. and 125 V. The charger will deliver about 3 amp. when connected to the 125 V. terminal, 5 amp. on the 115 V. terminal and 7 amp. on the 105 V. connection. When the case is removed the charging rate is 5, 7.5 and 9 amp., respectively. When using the 9 amp. rate, care should be taken to have at least a 12 amp. fuse in the receptacle on the terminal board because the current may momentarily rise to 10 amp. due to line variations.

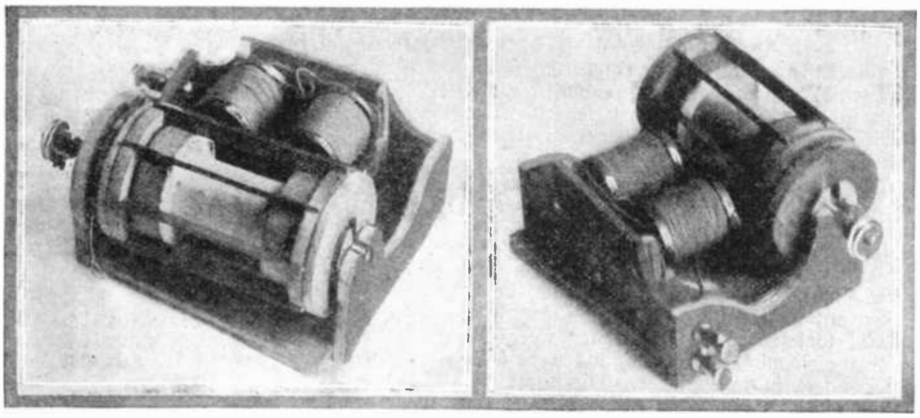
The "Tungar" rectifier can be used to charge ten 6-volt or five 12-volt "A" batteries at once in series by connecting the negative terminal of an end battery to the black lead of the charger and (disregarding the red lead entirely) connecting the positive terminal to the 105-V. connection on the terminal strip. The flexible wire must also be connected.

"B" batteries up to 60 volts may be charged. They should be connected as above, only a 50-watt light should be substituted for the fuse in the charger.

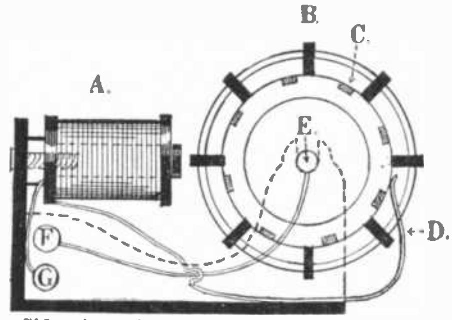
Contributed by Richard Stone.

Simple Cigar Box Motor

By Dr. E. Bade



Two views of a motor whose central feature is a common spool, the wood for the frame of the motor is supplied by the omnipresent cigar-box.

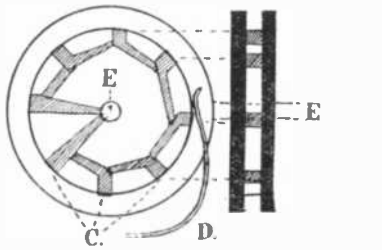


Side view of the motor; (A) is the magnet, (B) iron strips, (C) contacts, (D) spring which makes contact as the rotor turns, (E) shaft, (F) binding post and wire leading to shaft, (G) binding post and wire leading to magnet.

THE electric motor illustrated consists of two electromagnets on a soft iron base and an empty spool containing eight strips of soft iron, the whole running in a frame made from cigar box wood.

Take a spool about two inches in diameter, if possible to secure one so large; cut five round discs from cigar box wood which are half an inch larger in diameter than the spool, and one disc which is of the same diameter as the spool. Two of the larger discs are taken and eight equal parts measured off on the circumference.

Saw eight quarter-inch radial slots, nail or glue to the spool ends, and put iron strips in the slots, forcing them in tight so that they will be held firmly in position. Nail an insulating circular disc at each end. On the smaller disc also measure off eight equal parts and cut each part into four. On the first quarter of each eighth place a copper strip the width of the disc. This is the contact. Each contact touches the one in front and the two ends lead to the shaft, where it is soldered in place. Then nail the last circular disc over the contact disc.



General view of the connections of the spool motor. The letters used in the preceding caption apply to this one.

One binding post leads directly to the magnet, the other binding post leads to the shaft. The free end of the magnet wire leads to a spring making contact with the contact disc. Carefully adjust the spring so that contact is made when the iron strips are just above the core of the magnet. The connections are such as to permit current to flow at this point; the electromagnets attract the iron bar above it, draw it down, and when the bar is even with the magnet the current is broken.

The momentum given the shaft carries the iron strip past the magnet until contact is again made, when this strip is less in reach of the attractive effect of the magnet. The magnet then attracts the second strip of iron, draws it down, breaks contact and the strip travels on until the third contact is made attracting the third iron strip. It is in this way that the little electric motor is kept working. Six volts will run it satisfactorily, using either dry or wet cells.

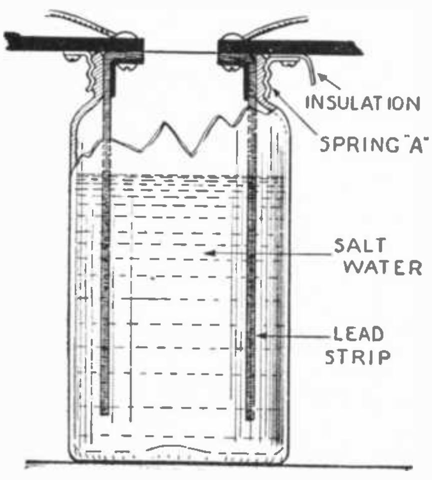
Liquid Resistance

By B. H. Moore

THE liquid resistance element described is made from a screw top Mason jar. The screw is used to hold the elements or electrodes in place.

Two pieces of fibre cut to the shape shown, provided with bent spring brass or steel corrugated pieces on their lower surface, have the lead plates attached, each to its own piece, at such a distance from the spring that the latter will be forced into the threads of the screw, or the plate may even be turned down by hand and screwed into place.

The lead at its upper end is reinforced by a bent bit of copper or brass to prevent its yielding to the pressure, which is quite high. The lead electrodes are about 3/32 inch thick, and ½ inch wide, and reach to about ¾ inch of the bottom of the jar. The connection of the two wires to the electrodes is shown in the illustration, and as constructed it is designed to be used in series in one lead of the circuit.



A simple but very effective water rheostat whose resistance may be varied either by altering the density of the salt solution or changing the depth to which the electrodes are immersed in it.

The best way is to make a solution of salt in water, put the electrodes in place, turn on the current and add water in which salt has been dissolved until a sufficient current is produced.

Another system involves the adding of water at the beginning and the addition of salt in small pinches until a sufficient current is produced.

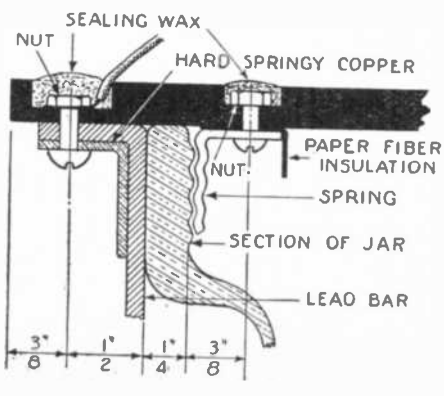
After the salt is added by small amounts, and before the current is turned on, it should be stirred to dissolve the salt, so that the strength of the current may be determined before adding more salt.

If the salt is left to accumulate in the bottom of the jar partly undissolved, the current will gradually grow stronger, as more salt enters into solution, and an insufficient amount of current may at first be received at the device to be run, and might eventually, as the solution becomes stronger, be enough to burn it out.

Care should be taken to turn off the current when salt is added. The current should be cut off when removing the lead bars for any purpose, to avoid the danger of bringing them into contact and shorting the circuit.

The hard fibre pieces should be kept dry and no salt should be allowed to collect on top of them. The connections on both bars are sealed with sealing wax as shown in diagram on next sheet.

The jar should not be filled more than two-thirds full to avoid water splashing on screws and fibre on top, which would lead to a direct contact. The jar should be two-thirds filled with water and the lead bars placed in it as shown; then with current turned off salt is added by small pinches at a time until current enough is received to run the device. Stir thoroughly before turning on the current.



A detail drawing showing the method of mounting the electrodes of the water rheostat.

Repairing Electric Fans—Electrical Testing

(Continued from preceding issue)

By H. Winfield Secor

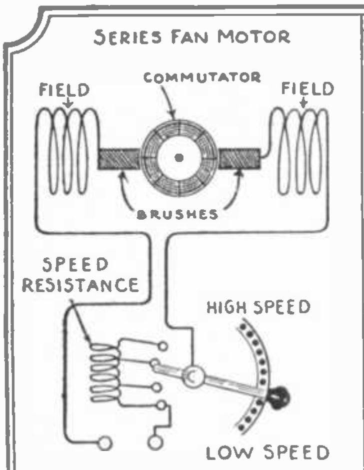


FIG. 4

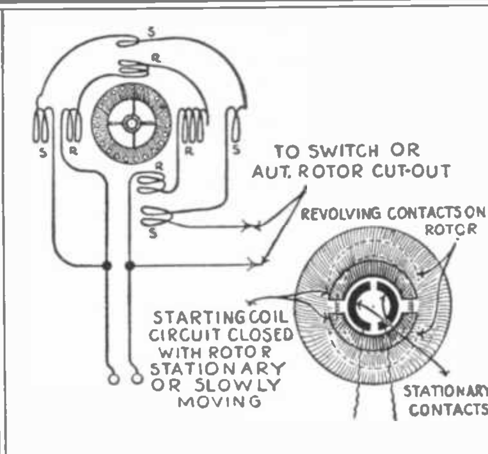


FIG. 5 SINGLE PHASE FAN MOTOR

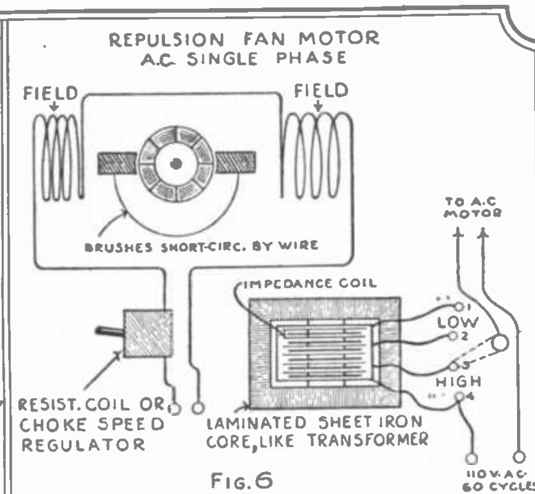


FIG. 6

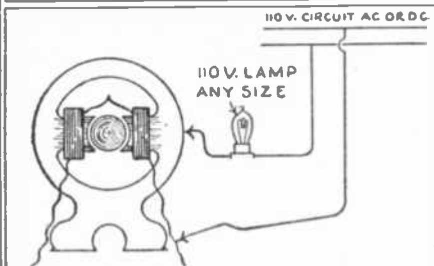


FIG. 7 GROUND TEST

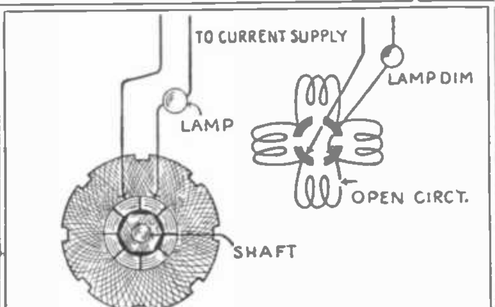


FIG. 8 TEST FOR OPENS
LAMP DIM WHEN WIRES BRIDGE OPEN COIL SEGS.

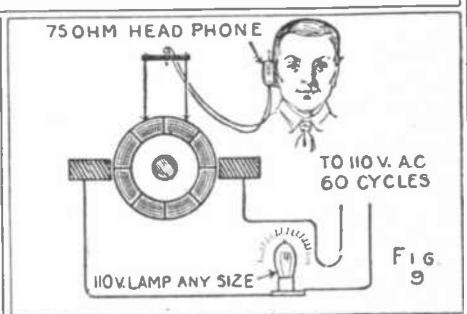


FIG 9

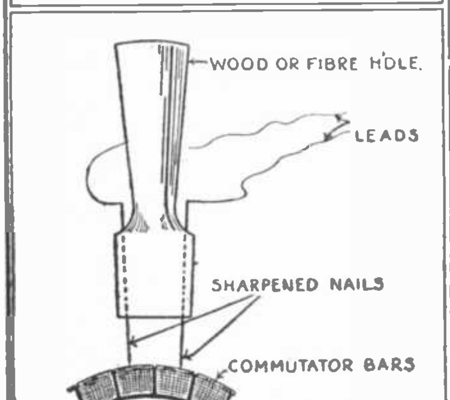


FIG. 10

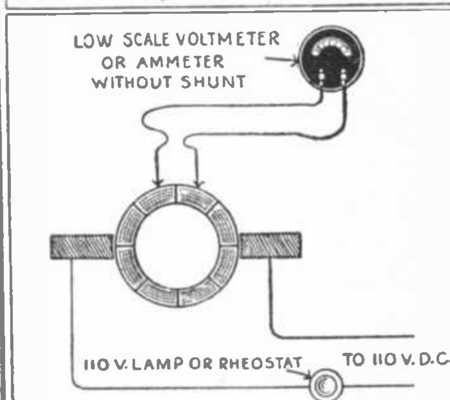


FIG. 11

Fig. 4 shows the electrical circuits of a series type direct current fan motor. The speed regulating resistance, the field coils and the armature are all connected in series, hence its name. Fig. 5 shows the electrical circuits of a single phase A.C. fan motor, provided with a starting winding on the stator, with an automatic centrifugal switch on the rotor, which opens the starting circuit as soon as the motor has attained normal speed. Fig. 6 shows electrical circuits of repulsion type fan motor. The armature brushes are short-circuited as seen. Fig. 7 shows test for "grounds." Fig. 8 shows test for open circuits in armature winding with 110-volt lamp connected in series with the circuit. Fig. 9 shows test for "opens" and "shorts" in armatures, using headphone. Fig. 10 shows testing handle with contacts, while Fig. 11 shows voltmeter bar-to-bar test.

THE commonest form of electric fan motor for direct current circuits employs a series winding, *i.e.*, the field coils are connected in series with the armature, as shown in Fig. 4; the speed regulation resistance is placed in the fan base.

Single phase alternating current fan motors with separate starting windings frequently have an automatic circuit opener for the starting winding, as illustrated at Fig. 5.

The repulsion type of A.C. fan motor is diagramed at Fig. 6. Here two brushes from an ordinary D.C. commutator or armature are short-circuited, and the motor operates due to the fields set up by the short-circuited armature windings and the alternating current magnetic field set up by the field coils which are connected to the A.C. supply through a resistance coil or choke coil for regulating the speed. Resistance coils are correct for D.C. fan motors, while a choke or impedance coil with a closed laminated iron core is the best suited for speed control of D.C. motors and is usually found in this class of motors.

Fig. 7 shows how the test for grounded windings or lead wires by means of a 110-volt lamp connected in series with the test leads indicated by the arrows may be made. The source of testing current may be 110 volts D.C. or A.C. A dry cell and a telephone receiver, or else a magneto-ringer and bell also serve as good testing appliances.

At Fig. 8 is shown one method of testing armatures for open circuits by means of a 110-volt lamp connected in series with 110 volts D.C. or A.C. An open-circuited coil on most armatures will be indicated when the lamp burns dim, the current having to pass through all the rest of the coils, as will be evident from the diagram. Test for grounds on armatures is made by placing one test lead on the shaft and then touching each of the commutator segments in turn with the other test lead.

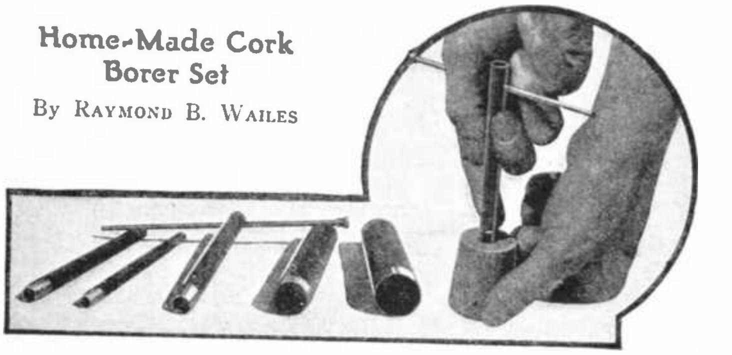
One of the most accurate and also the simplest test for short-circuited as well as open-circuited armature coils is that shown at Fig. 9. A 60-cycle A.C. from a 110-volt circuit is passed through a 110-volt lamp or other resistance and is connected to the brushes or else tied diammetrically on opposite points of the commutator, and the test is made with a 75-ohm or high resistance headphone bridged across two segments progressively. A certain strength of humming note will be heard when the coils are normal; a short-circuited coil will result in practically no noise being heard in the phone; a partial short will give a faint note, and an open-circuited coil will result in an extra loud note being heard in the phone.

Fig. 10 shows a simple test handle made from wood, or better still fibre or bakelite with two rods (nails) passing thorugh it and flexible lamp cord leads secured to the upper ends of the prods.

Fig. 11 shows a good test for shorts, opens and normal coils, using a low scale voltmeter or else an ammeter without a shunt, where 110 volts D.C. is available for test. A 110-volt lamp or suitable resistance is connected in series and the leads are tied diammetrically opposite on the commutator with several turns of string around the commutator, so that they can be shifted from time to time, and the drop of potential across any two segments or coil is then read on the meter. If the reading is low, there is a partial short; no reading indicates a full short between the segments or somewhere in the coil leads or the coil itself. A high reading indicates an open-circuited coil.

Home-Made Cork Borer Set

By Raymond B. Wailes



Cork borers are very useful tools in a laboratory and will save endless troubles arising from carelessly made holes in the corks. The borers illustrated at the left can be constructed without difficulty by any experimenter.

A MOST useful tool in the laboratory is a set of cork borers which are used to make holes in cork or rubber stoppers. Many experimenters punch a hole through stoppers with a nail, sometimes hot, and then again, with a hand drill. These two methods result in a very bad and loose job.

A set of cork borers can be made from thin walled brass tubing. Various sizes of tubing should be used, from three-sixteenths of an inch up to one inch in diameter.

A cutting edge is put on one end of each five-inch length of tubing by means of a grindstone or emery wheel. Rough edges can then be removed with a small file.

For a handle, drill a hole at the unsharpened end straight through both sides and half an inch from the end. Through this pass a steel rod or large nail which will serve as a handle for any one borer desired.

In boring the hole, place the sharp end of the borer in the center of the smaller end of the cork or rubber stopper and rotate the borer with pressure against the cork. Hold the cork against the edge of the table, the borer being held horizontally. The borer will then cut its way through to the other end of the stopper.

It is best to wet the stopper and the borer when making a hole through rubber stoppers.

Simple Geissler Tube

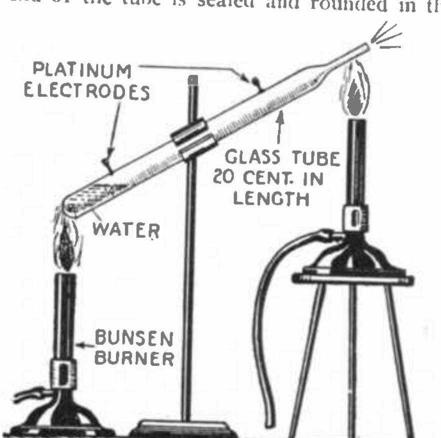
THE illustration shows an original and simple way of making a Geissler tube for working in conjunction with a high frequency resonator.

A suitable piece of soft glass tubing and two Bunsen burners are used. First one end of the tube is sealed and rounded in the flame of a Bunsen burner. Then about one cubic centimeter of water is put into the tube (of course it is first allowed to cool) and the other end is drawn out to a small opening. The water in the tube is now boiled and after the steam is coming off freely, the drawn-out end of the tube is sealed at the same time the boiling is stopped. Considerable care must be exercised in sealing the tube. The burner heating the water must continue to operate at a low flame until the tube is sealed, after which the flame is gradually turned down to prevent the soft tip from being forced inward, while the steam is condensing. When the steam condenses a partial vacuum is produced in the tube.

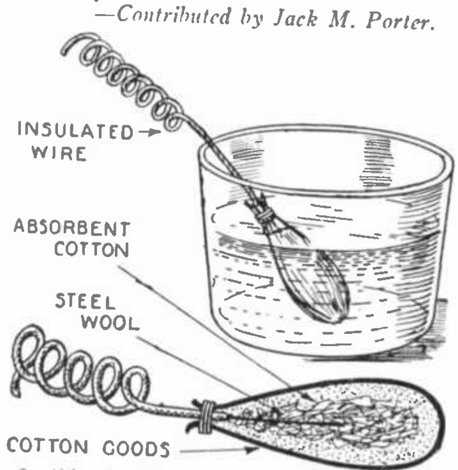
No terminals are required in this tube when used with high frequency, but platinum wires could be welded easily into the sides of the tube after one end was sealed.

This tube can only be used in a perpendicular position.

—*Contributed by Jack M. Porter.*



A method of making Geissler tubes in which evacuation is accomplished without the aid of a pump. The steam given off by boiling water expels the air and leaves a partial vacuum when it condenses.



In this electric polisher, the electrolytic action on the solution of salt and sodium bicarbonate makes the cleaning of metal utensils very easy.

Electric Polisher

THE electric cleaner is a device for cleaning metal such as silver and brass. It consists of a wad of steel wool wrapped around a piece of insulated wire with about one inch of insulation removed therefrom. Be sure it makes contact.

Then comes a thin layer of absorbent cotton and then a layer of cotton goods. Tie it securely as shown and the device is ready for use. Dip it into a solution of salt and sodium bicarbonate (baking soda) in water. The wire goes to the positive pole and the metal to be cleaned to the negative pole of a storage battery. The cleaner brightens the metal where it touches it.

—*Contributed by Arthur A. Blumenfeld.*

Stage Lighting Control

THIS control device for colored lights comprises a panel containing a rheostat and a number of S. P. D. T. switches. The lamps may be of any size, but should all be uniform in wattage and voltage.

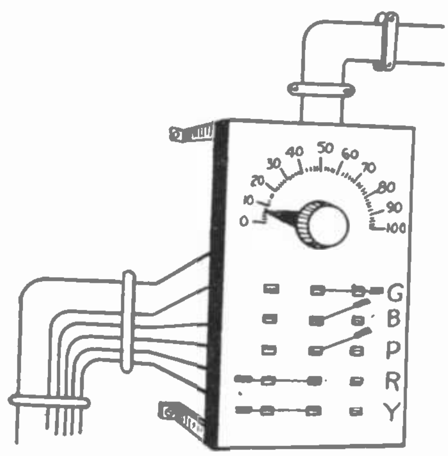


FIG. I

For small stages, this panel will provide an easy control system. The intensity of the light is regulated by the dial at the top which controls the rheostat.

The rheostat should be of a resistance sufficient to cut down the lamps from full brilliancy to a very dim effect. In Fig. 2, (G), (B), (P), (R) represent respectively green, blue, etc., lamps. Any number may be used in parallel, and by adding more switches, any number of colors may be used.

In both diagrams, lights "R" and "Y" are on full. Turning the rheostat from left to right causes the "R" and "Y" lamps to fade out and "G" to light up gradually. To light any one color instantly, throw the corresponding switch in the same direction as the rheostat is pointing. This device may be used with a few colored lights on a toy stage, or to control hundreds of lamps in a large theatre.

Contributed by W. L. Ellis, Jr.

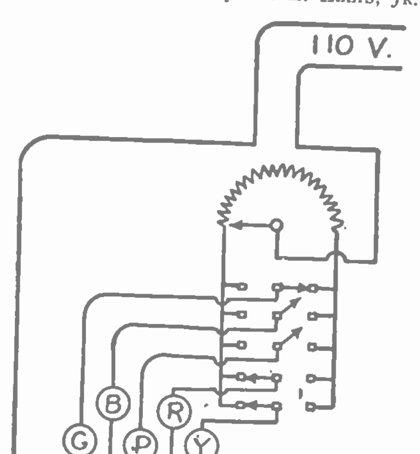


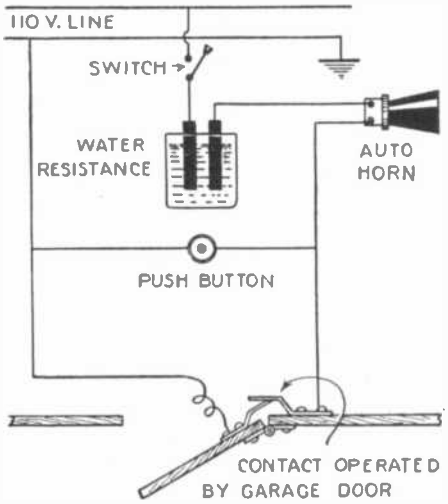
FIG. 2

With the switches set as shown, a gradual transition from a mixture of red and yellow light to a green light can be accomplished by turning the rheostat from left to right.

Garage Burglar Alarm

FEELING the need for a burglar alarm for my garage, I decided that if I made one, I wanted it to be effective. Taking a Ford magneto horn, which can be cheaply purchased at an auto wrecker's establishment, and testing it on the 110-volt 60-cycle A.C. circuit (through a water rheostat), I found that the volume was ample to fill the house.

In the event that the house lighting circuit is D.C., the magneto type horn will have to be replaced by the storage battery type of horn. It is much more effective than a bell or buzzer would be. The horn is installed in the automobile owner's bedroom and well insulated wires run from it. Two pieces of heavy clock-spring or spring brass are fastened to the wall on the inside near



This easily constructed garage burglar alarm sounds an auto horn when the garage door is opened. Two springs mounted near the hinges of the garage door close the horn connections to a 110-volt line.

the hinges in such a manner that when the garage door is opened, contact will be made between the two springs, thus causing the horn to blow. A switch is introduced into the circuit so that the rightful owner may take his car out of the garage without disturbing the peace.

Instead of the water resistance, if A.C. is available, a step-down transformer may be used for greater efficiency, but considering the infrequency of the operation of the thief alarm, it would hardly be worth the investment. The plates of the water resistance are clamped in such a manner that they cannot move about or touch each other. The apparatus is connected as shown in the accompanying diagram. The jar is filled with water and salt is added until by pushing the button, the horn gives forth the desired volume of sound. The bell-push is used to see that the circuit is operative without having to go to the garage and open the doors. The magneto horn may be used without resistance, but the lights will flicker slightly as long as it is connected and in action. According to a person who heard it, the volume of sound was enough to wake the dead.

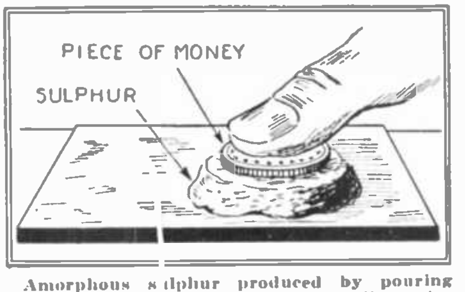
Contributed by JOSEPH A. MOFFITT.

Sulphur Casts

TO make sulphur casts easily, first make some amorphic and elastic sulphur by melting sulphur at a good heat and spilling it in cold water.

This may be moulded easily into beads, insulators, rods, etc., or impressions of coins or medals may be taken by it. These casts should be left alone for a few days, at the end of which they will have turned into hard, yellow sulphur.

Contrbiuted by Arthur A. Blumenfeld.



Amorphous sulphur produced by pouring molten sulphur into cold water will receive various impressions such as those of coins or can be molded into beads or insulators. On standing it becomes hard again, several hours being required.

Electric Coin Photographs

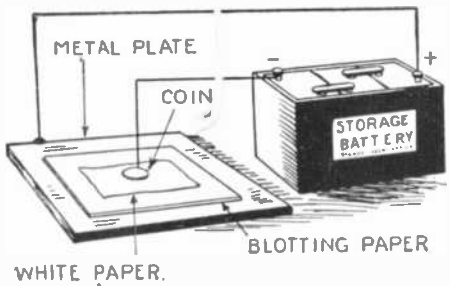
THIS experiment consists in taking pictures of coins with electricity instead of the usual manner.

A metal plate of zinc or copper as shown in (A) of Fig. 1, a few sheets of blotting paper (B), and some white paper (C), on which the image is to be produced, are necessary.

Connect the metal plate to the positive terminal of a battery of 12 volts, and with this done wet the blotting paper and lay it on the metal plate. On top of this set a piece of paper, which has also been moistened; then lay the coin on the paper and connect the coin with the negative terminal of the battery. In this manner let the current pass for a few seconds which is all that is necessary.

Upon examining the paper no visible effect is seen, other than that due to the mechanical pressure on the paper, but if the paper be treated in turn with a silver nitrate solution, and then with hydro-quinone, a clear black image of the coin is obtained. Any photographic developer other than hydro-quinone will produce the effect, and may be applied before or after the treatment with the silver nitrate.

Contributed by Carl Fischer.



The image of a coin resting on moist paper and connected to the negative terminal of a 12-volt battery as shown will be reproduced on the paper when the usual photographic developers are applied.

Double Service From Trouble Lamp

ODDS and ends of materials picked up about the home work shop or bought for a song may be easily combined in a stand that will make an ordinary garage "trouble" lamp serve also as a good-looking lamp to light up the bridge table. The base is a box 14 x 14 x 1½ inches deep, made of inch lumber (Fig. 1). Screw a half-inch pipe three feet long into a flange and attach the latter to the bottom of the box inside. Lacking a flange, one may simply bore a hole in the wood of such a size that the pipe will fit it snugly and then screw the pipe firmly into it. Weight the box well with lead, scrap iron or sand. Put the top section (Fig. 2) in place and fasten it with finishing nails. A "dome of silence" caster under each corner of the base makes the stand easy to move and saves floors.

Bend at right angles a half-inch rod four feet long so that the shorter arm is 14 inches long. The longer arm must work freely inside the pipe. From a piece of hoop iron or similar material fashion the clamp, Fig. 3. This has three lugs, each reinforced with a rivet. The ends are closed by a bolt with a thumb nut. This clamp must grip the rod firmly. Its purpose is to adjust the height of the lamp.

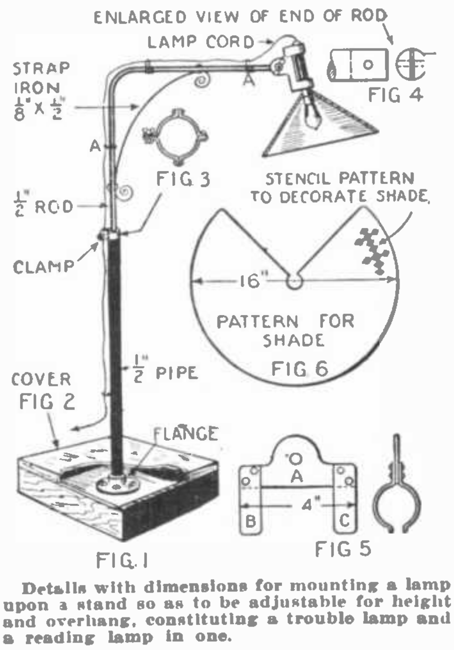
The ornamental bracket is made of strap iron, ⅛ x ½ inch. It is fixed in place by a bolt or rivet through each arm of the rod.

With a hacksaw cut an up-and-down slot in the end of the shorter arm of the rod. Drill a hole horizontally through it (see Fig. 4). Cut (A) and four pieces like (B) and (C), Fig. 5, from spring brass or steel of about 24 gauge. At each end of (A) are two pieces (B) and (C) fixed to either side of (A) by rivets (a, Fig.5). These pieces are bent as shown at (C C') in the end view, Fig. 5, to grip the handle of the trouble lamp. (A) is drilled (b, Fig. 5) and then inserted in the slot sawed for it (Fig. 4 and B, Fig. 1). A light bolt with a thumb nut holds it in place and permits the adjusting of the light to any desired vertical angle. By raising the upper section of the stand and swinging the light well forward one may quickly convert the bridge lamp into a mighty useful piano lamp.

Fig. 6 shows a good shade pattern. Cut from parchment or good cardboard a circular disk 16 inches in diameter. Cut out a quadrant, bring the straight edges together and secure them with glue or staples. A parchment shade may be dyed any desired color and then rendered semi-translucent by saturating it with a half-and-half mixture of turpentine and linseed oil. A cardboard shade should be painted, preferably an apple green or a light tan. Decorate the shade, whichever material is used, with a stenciled design, using thick paint of a color somewhat darker than that of the body of the shade. An easily made stencil pattern is suggested in Fig. 7. Space the figures about an inch apart entirely around the shade, one-half inch from the lower edge.

The opening at the apex of the shade should be just large enough to admit the two-piece plug and the handle of the trouble lamp. As the wire guard is left on the lamp, one needs only to slip the cord from the wire hooks (A, Fig. 1), release the handle and slip off the shade to make the lamp ready for "trouble" service.

Give the wooden base a deep, satiny mahogany finish and then enamel the metal parts of the stand ivory, tan or apple green, whichever will harmonize best with the furnishings of the room.



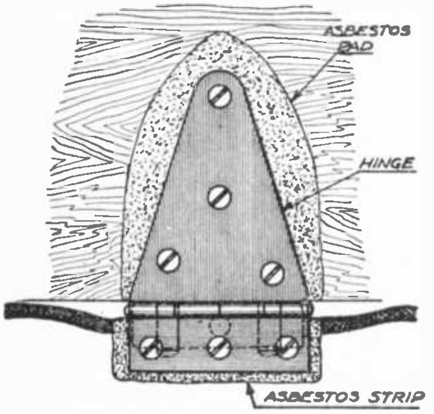
Details with dimensions for mounting a lamp upon a stand so as to be adjustable for height and overhang, constituting a trouble lamp and a reading lamp in one.

Awards in the $50 Special Prize Contest
For Junior Electricians and Electrical Engineers

First Prize, $25.00	Second Prize, $15.00	Third Prize, $10.00	Honorable Mention
H. P. Clay, 1224 Ellis St., Kingsburg, Calif.	John E. Lambert, Champlain, New York	Hugo E. Anderson, 340 E. Tamarack St., Ironwood, Mich.	Charles Field, 95 Park Ave., Athol, Mass.

First Prize
Electric Flat Iron Switch

THE electric flat iron switch shown in our illustration is semi-automatic in that it is operated to turn off the current by the weight of the iron when placed on the iron rest. The current has to be turned on by

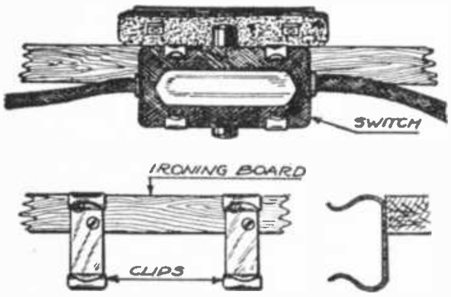


The top view of the electric flat iron switch. The pressure of the iron on the free portion of the hinge opens the heating circuit by a feed-through switch.

pressure of the finger, since it would be hardly practical to do this by means of a spring.

The flat iron rest consists of a thick strip of asbestos cut to the same shape as the bottom of the electric iron and at least one-half inch larger all around. A strap hinge similar to the one shown is laid on the asbestos strip and both are screwed to the ironing board with the large end of the strip and the hinge pin exactly at the edge of the board. If the asbestos strip is thick enough part of it could be cut out so that the hinge is embedded level with the top of the strip. If this cannot be done, then narrow strips of asbestos could be placed around the hinge to make a flat rest for the electric iron.

A small strip of asbestos is fastened to the smaller movable part of the hinge with



The feed-through switch mounted beneath the hinge. The clips supporting the switch are shown below it.

short bolts. Directly under the small end of the hinge, extending from the edge of the ironing board, are placed two metal clips of the size and shape that will hold a feed-through switch. The illustration shows the arrangement plainly.

The feed-through switch is connected in the electric iron cord. When beginning the ironing, the feed-through switch is slipped into the clips with the "on" button projection raising the small end of the hinge slightly. When it is desired to turn off the current, the electric iron is set on the rest so that part of its weight presses down the small end of the hinge, which then causes the "on" button projection to be pushed down to the "off" position.

The best feature of this device is that it is operated by the natural action of placing the iron on the rest, practically eliminating the danger of leaving current on the electric iron when the housewife is called away suddenly.

Second Prize
Simple Motor Reversing Switch

THE reversal of direction of rotation of a direct current motor is effected by reversing the direction of the current in the armature or in the field windings. A simple arrangement for doing one or the other of these things is given here.

The positive pole of the battery goes to the lower contact on the jack and thence to the armature post. The minus pole goes to the single pole switch, from the switch to the above connection on the jack, and thence to the armature post. The two inside connections of the jack go to the field coil and thence to the plug. If the motor does not reverse, shift the connection in the plug and it will. The parts needed are as follows:

A double circuit jack, a plug and a single pole switch.

$50 IN PRIZES

A special prize contest for Junior Electricians and Electrical Experimenters will be held each month. There will be three monthly prizes as follows:

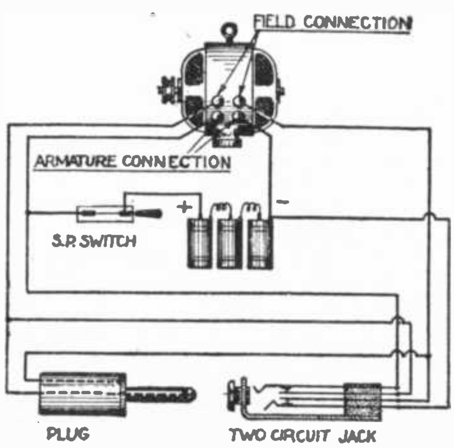
First Prize	$25.00 in gold
Second Prize	$15.00 in gold
Third Prize	$10.00 in gold
Total	$50.00 in gold

This department desires particularly to publish new and original ideas on how to make things electrical, new electrical wrinkles and ideas that are of benefit to the user of electricity, be he a householder, business man, or in a factory.

There are dozens of valuable little stunts and ideas that we young men run across every month, and we mean to publish these for the benefit of all electrical experimenters.

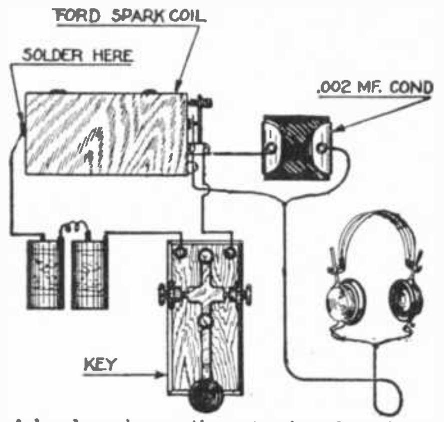
This prize contest is open to everyone. All prizes will be paid upon publication. If two contestants sumbit the same idea, both will receive the same prize.

Address, *Editor, Electrical Wrinkle Contest*, in care of this publication. Contest closes on the 15th of each month of issue.



An ingenious circuit in which the insertion of the plug reverses the electric motor.

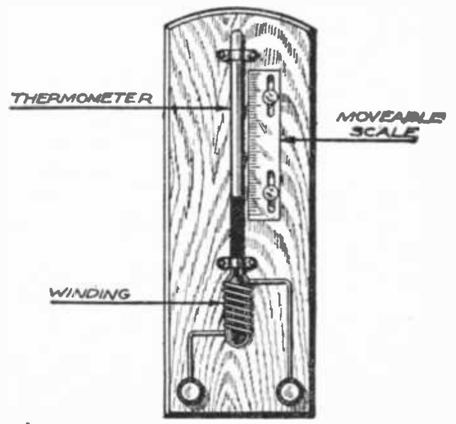
Third Prize
Code Practice Set



A handy code practice set using the primary of a Ford coil to give the buzzing sound of radio code transmission.

THE apparatus needed in the code practice set is as follows: Two or three dry cells, telegraph key, Ford spark coil, pair of radio receivers or head phones, and a .002 microfarad fixed condenser. The connections are made as shown in Fig. 1, and the set is operated by the telegraph key. The secondary of the spark coil is not used and may be removed altogether without spoiling the operation of the set in the least.

Honorable Mention
Simple Ammeter



An ammeter; the bulb of a mercury thermometer is wound with a wire carrying the current, so that the heat affects the height of the column.

What Our Readers Think

Home-Made vs. Store Goods

Editor, THE EXPERIMENTER:

I am a regular reader of THE EXPERIMENTER and think that it is the best magazine for the unadvanced experimenter in the country.

However, I have some criticisms to make. Do you think that you are keeping up the exceptionally high standard that you began with? I have just purchased the May issue and am a little disappointed with it. When comparing it with the December and January issues I find that there are not as many interesting experiments which we experimenters can perform.

I think that articles on the construction of home-made variable condensers and audio frequency transformers are foolish. For can we not buy much more efficient and well made apparatus of that nature at a nearby store for slightly more money?

My greatest interest is in chemistry and physics. I am particularly interested in the mercury vapor arc, ultra-violet light and fluorescence.

I certainly think THE EXPERIMENTER is a fine magazine.

Yours truly,
CHARLES H. SHAW.

(Our leading principle is to favor home experiments and we feel that the suggesting of the making of radio apparatus by the experimenter is exactly in line with the policy of our publication. Think it over and we are sure that you will agree with us.—EDITOR.)

Our Front Covers

Editor, THE EXPERIMENTER:

I have really been very selfish in not writing to you sooner to tell you about your wonderful magazine, THE EXPERIMENTER.

I call it wonderful because it contains just exactly what I have longed for for several years.

I have looked for and devoured every experiment I could possibly find for many years. But this is the first time I have ever found so many things under one cover.

I would like more in the way of chemistry, and hope that you will keep up the good work in the way of electricity and physics.

I have read every one of THE EXPERIMENTERS that have come out and find them crammed full of delicious things for the inventor and experimenter.

I do not think that you should change the style of your front cover, because if it had not been for the front cover on the first magazine, I might never have discovered it.

Your truly,
HOWARD FOWLER.

(It may seem from the editorials which have been published on the first page of our successive issues that the Editor of this magazine may fairly be termed a devotee to experimenting. Our desire is that this paper shall be distinctively a description of experiments and a means of communication for experimenters with the public, and nothing pleases us more than to get good and novel experiments from our readers. We think that the past issues have had much added interest from the fact that so much of the copy has come from real workers in science.—EDITOR.)

Afraid the Experimenter Will Give Too Much Radio

Editor, THE EXPERIMENTER:

I have just received my June issue of THE EXPERIMENTER and I thought that I would write you and tell you what I think of it. I have been a reader of PRACTICAL ELECTRICS since July, 1922, and always liked it very much. However, when you changed the magazine into THE EXPERIMENTER, enlarging its scope, I thought that I would not like it at all; and had decided to let my subscription lapse. But you have convinced me.

Heretofore, I didn't botner with chemistry at all, and never had the time or money to take up radio, but now I have established a chemical branch of my laboratory and read the chemical section of THE EXPERIMENTER with as much interest as the electrical. However, there is one danger that I would like to caution you against. There is no doubt that radio is the most popular science of the day, and there are a great many magazines devoted entirely to it. Chemistry and electricity are just as important sciences and the amateurs "practicing" them need just as much support as those delving in radio, so *don't let* THE EXPERIMENTER *gradually become an entirely radio magazine.*

The composition of the magazine is fine, maybe a little racy at times for a Britisher, but altogether good.

Wishing all kinds of success to you and THE EXPERIMENTER (and don't forget lots of electrical experimental articles).

Yours sincerely,
CLARE R. TRACY.

Toronto, Canada.

These columns are reserved for *YOUR* opinions. Do not hesitate to communicate your comments and suggestions regarding THE EXPERIMENTER.
—EDITOR.

Patents and Publication

Editor, THE EXPERIMENTER:

I wish to seek a little information regarding your editorial entitled "The Purpose of Experimentation" in the February issue of your magazine.

You state, "From the minute the experiment is published in a national publication you have two years within which to make a patent application." I have always been of the opinion that when such said experiments are published and paid for they become the property of the publishers.

Will you kindly set me right on this?

Thanking you, I am,

FRANK R. MOORE.
Reporter No. 1993.

Detroit, Mich.

(The publication of an article with remuneration given to the author conveys no right whatever to the invention. The law is very strict on this and analogous points. A man can be paid for inventing and then has to assign the invention to his employer, but unless this is in the contract of employment, the invention belongs absolutely to the inventor.—EDITOR.)

More About the Disc Loud Speaker

Editor, THE EXPERIMENTER:

As you have suggested in your Experimental Radio Department, I am writing to let you know that I have constructed one of the new paper disc loud speakers and find it as good as you claim, with no noises and very clear operation, of course not as loud as a power horn, but sufficiently loud for a large sized room.

I have shown it to a few friends and they are thinking of making it. Will send you a photograph of mine soon. Thanking you for wonderful instruction,

Sincerely,
LOUIS J. ANDREATTA.

Clifton, N. J.

(We will be very glad to receive a photograph of your loud speaker. One of our readers as you will notice, has tried animal membrane in place of the pleated paper. There is considerable interesting experimentation to be done along this line. By all means send us the photo.—EDITOR.)

Flame Tests. Magnetization

Editor, THE EXPERIMENTER:

Please publish the list below in THE EXPERIMENTER:

The flame test for zinc, aluminum, lead, babbitt, pewter.

Also fusing point of each one.

Please publish an electro-magnetizer, using stovepipe iron for lamination. I would like to magnetize horseshoe magnet, bar magnets, etc.

Yours cordially,
F. E. ELLIOTT.

San Diego, Calif.

(If metallic zinc is heated in the oxidizing flame of a blow-pipe or of a good Bunsen burner, it will burn quite brilliantly, somewhat as magnesium does, but with a greenish tinge. If you can get aluminum to burn, the flame will be nearly white. A flame can be produced from lead by heating it on charcoal in the blow-pipe flame, but it is not very striking. Babbitt and pewter will of coures give the lead flame. The fusing points are the following:

Lead, 630 degrees F.
Zinc, 761 degrees F.
Aluminum, 1157 to 1,214 degrees F.

Babbit and pewter will vary in fusing point with their composition.

You can magnetize a steel bar by surrounding it with a coil of insulated wire and passing a heavy current through. It you want to make an electro-magnet for the purpose you will find several such given in our columns. We especially refer you to our issues of November, 1924, page 40, and February, 1925, page 258.

Excite the magnet with a strong current and stroke the steel bar. If your magnet is of horseshoe type, attach by attraction pole to pole, and rock it back and forth as it adheres. The jarring is an element in giving a good result.—EDITOR.)

The Rabinowitz Audio-Transformer

Editor, THE EXPERIMENTER:

I have made an audio-transformer following the instruction given by Mayer Rabinowitz in your February issue of THE EXPERIMENTER and it sure does the business. I have compared it with one that costs $3.00 and can see no difference.

Yours truly,
PAUL BAUER.

Long Prairie, Minn.

He Is Not a Hard Critic

Editor, THE EXPERIMENTER:

May I take the opportunity of congratulating you upon the revival of THE EXPERIMENTER. In the old days it was a great friend of mine. I continued to take it for some time after it was changed to SCIENCE AND INVENTION. Keep the good old "Exp." going this time. The boys in the country are very keen on it. I am also an enthusiastic reader of *Radio News*—long life to both of them.

Now as to contents of the "Exp." your editorials are fine, the general section is O. K. Exp. Radio, New Things Electric, Exp. Chem., are O. K. I don't care much for Historic Experiments. The fiction is good but it seems to me rather out of place as do "Short Circuits." Don't think I am a hard critic, it is only my opinion and of course you must go by the opinion of the majority, but above all keep the good old "Exp." going.

Sincerely yours,
J. V. NEWSON.

London, England.

The Disc Loud Speaker Again

Editor, THE EXPERIMENTER:

I have tried out the loud speaker described in the May issue of THE EXPERIMENTER and have found that a beef-bladder was far superior to paper.

I soaked it in water until soft and pliable and then stretched it on the frame to dry. After drying I proceeded as described in the article. The results are superior, and the trouble of pleating the paper as in the paper disc is avoided.

Yours truly,
JAMES YOUNG.

Oakland, Calif.

(We are very glad to get this contribution, giving us the result of this very practical and interesting experiment, which seems to have led to an improvement in a really practical loud speaker.—EDITOR.)

A Correction by the Author

Editor, THE EXPERIMENTER:

In my article recently published by you, entitled "Experiments with Catalysis—Good Samaritans" I stated in the text referring to one photograph which showed a circle of filter paper being immersed in strong sulphuric acid, that the cellulose is converted into starch which is tested for by means of tincture of iodine, forming a blue color.

The wording should read that the cellulose has been changed into *dextrin* and NOT STARCH. The blue color with iodine is produced just the same as if starch was formed.

The article appeared in the February issue.

Hoping that you will make this correction, I am,

Faithfully yours,
RAYMOND B. WAILES.

Washington, D. C.

Electrolytic Light

Editor, THE EXPERIMENTER:

In the April issue of THE EXPERIMENTER a very interesting article on Light by Electrolysis appeared.

A striking example of this was called to my attention last night. I was making the "B" eliminator described in the May issue. I had the device connected to form the plates with two sixty-watt lamps in parallel connected in series with the rectifier. A soft, white light seemed to be emanating from the aluminum electrode. I thought it might be a reflection from a light in the hall but found that it was caused by the current passing through the cell.

Another interesting experiment to perform is to hold two magnets taken from an old inductor magneto near a 60-160-watt bulb. The filament vibrates rapidly and soon welds together in two or three places making a much more brilliant light.

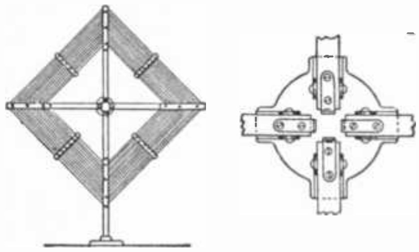
Yours truly,
JAMES KEZER.

Port Collins, Colorado.

(Referring to the latter part of your letter, the reason why an incandescent bulb gives much more brilliant light under the conditions is obviously that the resistance of the filament is decreased by welding several parts of it together. The result of such welding is that these parts become connected in parallel or that the ignited wire is shortened.—EDITOR.)

Latest Electrical Patents

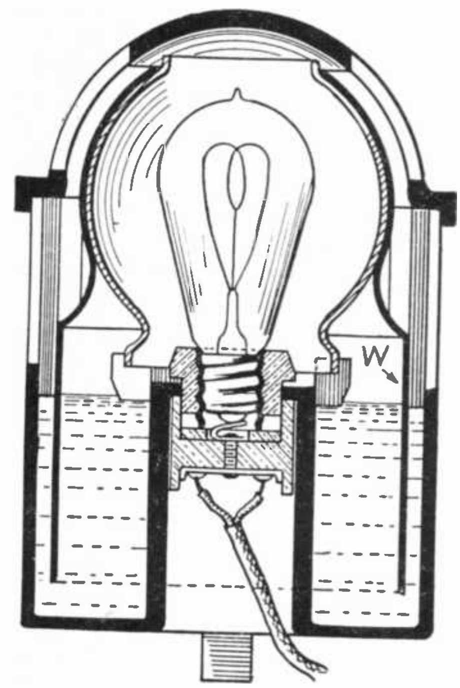
Collapsible Loop Antenna



This loop antenna can be readily extended into its normal position, and when this is done the four arms become locked. Additional spacers are provided to keep the wires parallel.

Patent No. 1,536,997 issued to A. E. Wyatt, Jersey City, N. J.

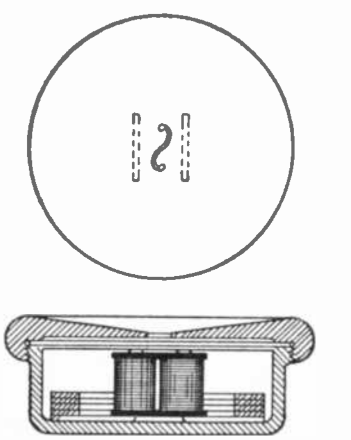
Humidifier



A wick whose ends are immersed in a small water basin draws the water up over and to the top of a globe where it is exposed to heat produced by an incandescent bulb within the globe. The water in this way is continuously evaporated.

Patent No. 1,522,755 issued to E. M. Soreng, Chicago, Ill.

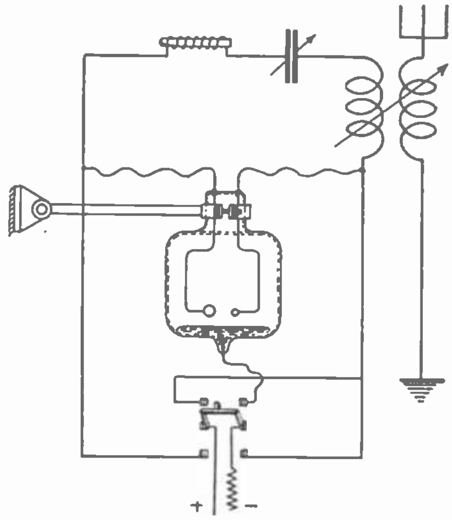
Telephone Diaphragm



It is claimed by the inventor of the diaphragm that by cutting out parts of the diaphragm as shown a purer vibration is obtained, because the electromagnetic flux is thereby balanced.

Patent No. 1,536,486 issued to H. Fischer, New York, N. Y.

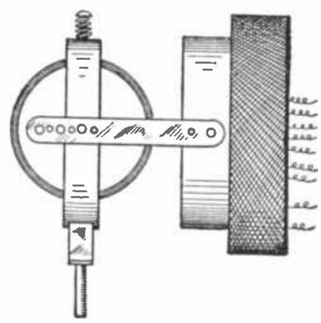
Mercury Arc Oscillator



The oscillator comprises an arc between solid electrodes in an atmosphere of a mixture of hydrogen and mercury vapor at a relatively high pressure whereby a fine stream discharge is secured.

Patent No. 1,537,021 issued to H. C. Rentschler, Wilkinsburg, Pa.

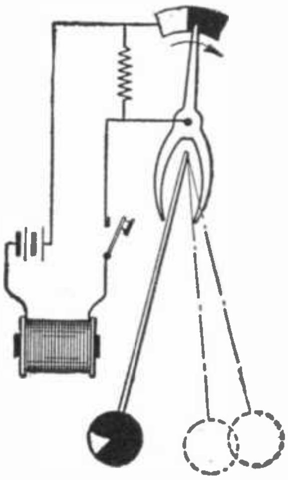
Adjustable Vario-Coupler



The rotor of this coupler is not surrounded by the stator as is the usual case. Its distance from the latter is adjustable. It is claimed that the distributed capacity of the inductance coils is in this instrument reduced to a minimum.

Patent No. 1,523,466 issued to R. L. Walker, Atlanta, Ga.

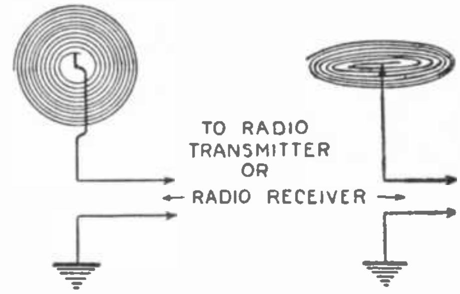
Electromagnetic Clock Pendulum



This pendulum by means of the electrical interrupter shown keeps the amplitude of its vibrations at a predetermined value. The main interrupter is represented by the switch, while the auxiliary interrupter actuated by the pendulum is shown at the top of the figure where the white and black segments are of conducting and insulating materials respectively.

Patent No. 1,523,762 issued to N. P. Favre-Bulle, Boulogne, France.

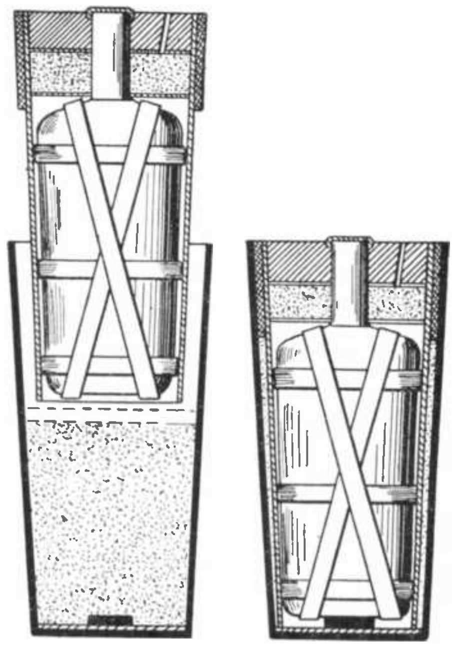
Compact Antenna System



The inventor proposes to use, in place of a long antenna, a small spiral coil wound with a sufficient number of turns to give the necessary inductance and capacity in the system.

Patent No. 1,530,684 issued to J. O. Mauborgne, et al, Washington, D. C.

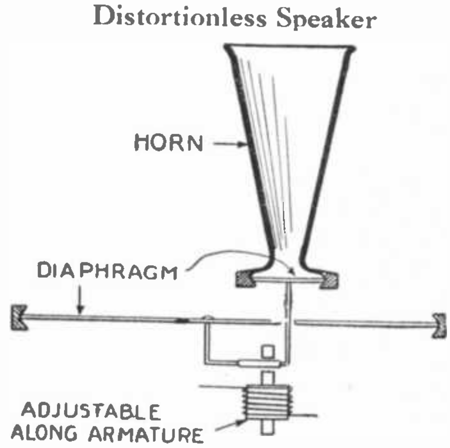
Non-Polarizing Dry Cell



To prevent deterioration of the cell while in stock, the battery is constructed as shown in the figure, that is, with the carbon electrode kept out of the electrolyte. When in use, the telescoping parts of the cell are forced together and the electrolyte surrounds the carbon.

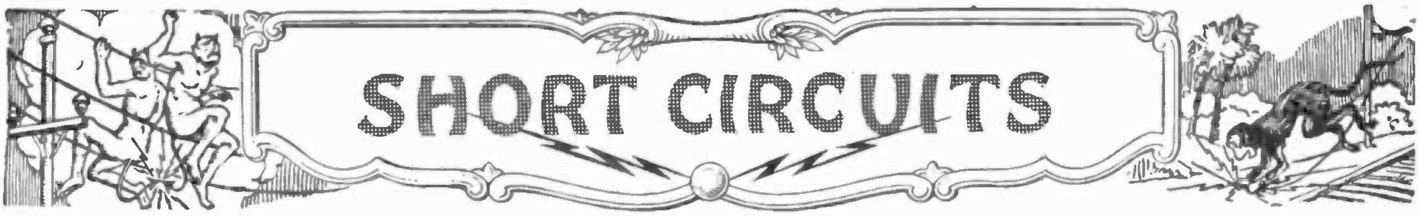
Patent No. 1,533,012 issued to H. M. Koretzky, Brooklyn, N. Y.

Distortionless Speaker



This loud speaker is provided with two diaphragms of different dimension and different degrees of stiffness. One of these diaphragms has a natural period corresponding to low telephonic frequency and the other to high telephonic frequency. The two diaphragms are mechanically connected to be operated by a single electromagnet.

Patent No. 1,536,118 issued to B. S. McCutchen, North Plainfield, N. J.

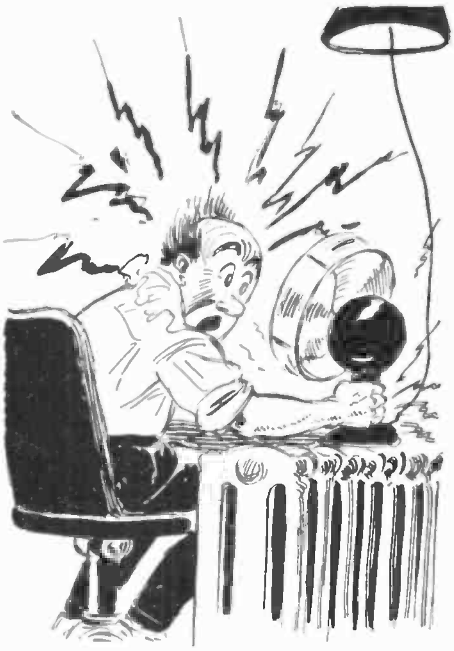


SHORT CIRCUITS

THE idea of this department is to present to the layman the dangers of the electrical current in a manner that can be understood by everyone, and that will be instructive too. There is a monthly prize of $3.00 for the best idea on "short-circuits." Look at the illustration and then send us your own particular "Short-Circuit." It is understood that the idea must be possible or probable. If it shows something that occurs as a regular thing, such an idea will have a good chance to win the prize. It is not necessary to make an elaborate sketch, or to write the verses. We will attend to that. Now, let's see what you can do!

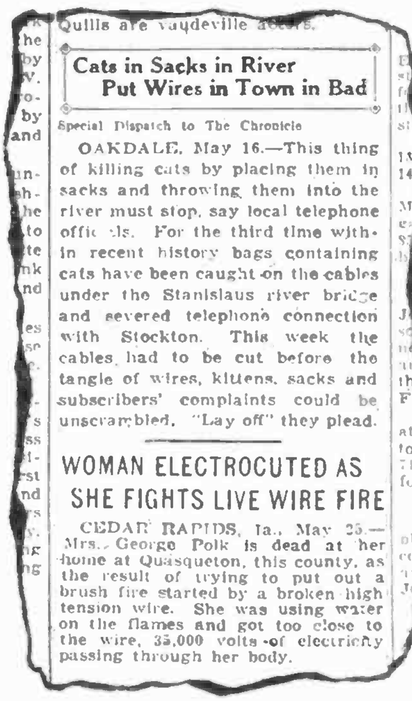
Sad was the death
Of poor Mary McBriar,
Who trained her garden hose
On the trolley wire.
—Charles Lawrence.

Here lies the body
Of Harrison Russ,
Who struck a trolley wire
While riding on a bus.
—Gilson Willetts.



Here lie the bones
Of Chester McKator.
He set his fan
On the radiator.
—Charles W. Cannon.

Beneath the sod
Lies switchman McBeaver,
Who grounded himself
Through the control lever.
—George Stiles.



Quills are vaudeville actors.

Cats in Sacks in River Put Wires in Town in Bad

Special Dispatch to The Chronicle

OAKDALE, May 16.—This thing of killing cats by placing them in sacks and throwing them into the river must stop, say local telephone offic als. For the third time within recent history bags containing cats have been caught on the cables under the Stanislaus river bridge and severed telephone connection with Stockton. This week the cables had to be cut before the tangle of wires, kittens, sacks and subscribers' complaints could be unscrambled. "Lay off" they plead.

WOMAN ELECTROCUTED AS SHE FIGHTS LIVE WIRE FIRE

CEDAR RAPIDS, Ia., May 25.—Mrs. George Polk is dead at her home at Quasqueton, this county, as the result of trying to put out a brush fire started by a broken high tension wire. She was using water on the flames and got too close to the wire, 35,000 volts of electricity passing through her body.

This black earth entombs
Mechanic John Raymond
Who used our electric drill
On a wet pavement.
—G. C. Lutes.

In connection with our Short Circuit Contest, please note that these Short Circuits started in our November, 1921, issue and have run ever since. Naturally, during this time, all of the simple ones have appeared, and we do not wish to duplicate suggestions of actual happenings or short circuits. Every month we receive hundreds of the following suggestions, which we must disregard, because they have already appeared in print previously. Man or woman in bath tub being shocked by touching electric light fixture or electric heater. Boy flying kite, using metallic wire as a string, latter touching an electric line. People operating a radio outfit during a thunderstorm. Stringing an aerial, the latter falling on lighting main. Picking up a live trolley wire. Making contact with a third rail. Woman operating a vacuum cleaner while standing on floor heating register, etc. All obvious short circuits of this kind should not be submitted, as they stand little chance of being published.

THIS department is conducted for the benefit of everyone interested in electricity in all its phases. We are glad to answer questions for the benefit of all, but necessarily can only publish such matter as interests the majority of readers.

1. Not more than three questions can be answered for each correspondent.
2. Write on only one side of the paper; all matter should be typewritten, or else written in ink. No attention can be paid to penciled letters.
4. This department does not answer questions by mail free of charge. The Editor will, however, be glad to answer special questions at the rate of 25 cents for each. On questions entailing research work, intricate calculations, patent research work, etc., a special charge will be made. Correspondents will be informed as to such charge.

Kindly oblige us by making your letter as short as possible.

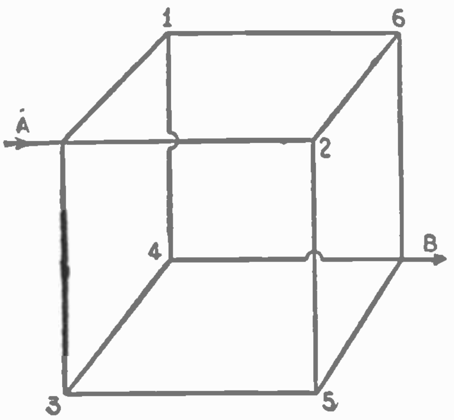


FIG. 1

The determination of the joint resistance of this network, each member of which has a resistance of one ohm, requires much ingenuity.

Armature Bore

(526) Sidney Finkelstein, Bronx, New York, writes:

I have heard the expression "armature bore." What does this mean? The only bore I can see about an armature is the hole through which the shaft passes.

A. 1. The expression "armature bore" is often used to indicate the cylindrical space between the field magnet poles within which the armature rotates, especially as applicable to the bi-polar mode of construction. In other words, instead of being a hole or bore through the armature, it is the hole or bore into which the armature fits.

The term is rather a good one, because to lower the reluctance of the path of the lines of force the space between the outer surface of the armature and the inner surface field magnets is made as small as possible. From the standpoint of this dimension one thing is to be looked out for. The rapid rotation of the armature tends to throw the wires out, so there must be a little bit of allowance made for this centrifugal displacement. Of course, this should not be required. The wires should be held absolutely rigidly in place.

Alarm Clock for Radio Set

(527) Grantland Duncan, Long Branch, N. J., asks:

Q. 1. Would it not be a good idea to arrange some kind of a clock to open the circuit of a radio set so that one would not fall asleep and have the battery exhausted, or perhaps going away in an interval of silence, retire for the night and leave it turned on all night long? This happened recently in the writer's home and undoubtedly it happens in many others.

A. 1. It would be a very simple matter to arrange an alarm clock to open the circuits at any desired time, say at ten or half-past ten o'clock. If this is too early, the clock could be reset for half an hour or an hour later and the switches closed again. It would seem that this might be made a permanent part of all high grade receiving sets, but there would be little or no trouble in constructing a homemade one.

A Problem Solved

ON page 272 of our February issue, there was printed a test question translated from our German contemporary *"Radio"* in which was portrayed a cube as shown in Fig. 1.

The problem was to determine the resistance between A and B, considering that each side line had a resistance of one ohm.

Simple as the example seems upon first consideration, the numerous replies that we received indicate that it was no snap problem.

Since the connections of Fig. 1 are symmetrical, it is obvious that, referring to Fig. 2 the voltage drop in A-1, A-2 and A-3 are equal; the voltage drop between 1 and B, 2 and B, 3 and B are equal. The three facts enumerated permit phantom connections to be made of the points 1, 2 and 3, and points 4, 5 and 6, because there is no potential difference between 1 and 2, 2 and 3, 3 and 1, or between 4 and 5, 5 and 6, and 4 and 6.

When the phantom connections are made as shown in Fig. 3, we see at a glance that there are three groups of parallel resistances.

The joint resistance A-C........... $\frac{1}{3}$ ohm
The joint resistance C-D........... $\frac{1}{6}$ ohm
The joint resistance B-C........... $\frac{1}{3}$ ohm
The joint resistance A-B........... $\frac{5}{6}$ ohm

Those who solved the problem correctly were, in the order of the merits of their exposition: B. W. Lee, Moline, Ill.; Joseph J. Pire, Washington, D. C.; Frank Romeo, Newark, N. J.; Frank Shlaudeman, Decatur, Ill.; P. K. Jeffrey, Bexley, Ohio; E. J. Horace, Pittsburgh, Pa.; Robert H. Canfield, Baltimore, Md.; Homer Bretz, Jackson, Mich.; Alek Sienkowski, San Diego, Calif.; Max Steinberg, Toronto, Canada; J. Kinzer, Hoboken, N. J.; R. H. Christ. E. Lexington, Ky.

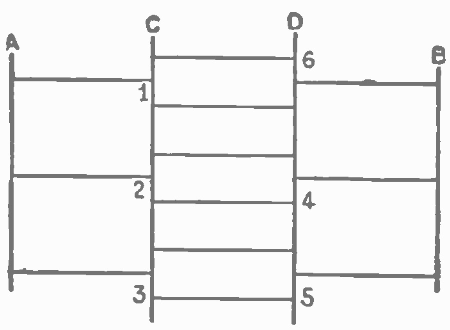


FIG. 3

An equivalent circuit of the cubical network shown in Fig. 1.

Material for Crucibles

(528) Roy Duncan, Anderson, Calif., writes:

Q. 1. When experimenters learn from your columns that they can make electric crucibles cheaply, the first question in their minds will be, "Where can I get the materials that I lack?" Hardware stores carry asbestos in one form or another, but do they carry resistance wire that will stand a high temperature? Do they carry clay suitable for making crucibles?

A. 1. Clay is carried by many hardware stores; it is an article of kitchen use for mending stove linings and the like. As regards resistance wires, about the most obvious way to get them is to take them from the heating elements of flat-irons or other household appliance. You will also find asbestos cement, which is one of the requisites of some furnaces in hardware stores Sometimes a paint store will carry these materials.

You need not feel any hesitation in sending a postcard to dealers asking for prices, as it entails no obligation to purchase.

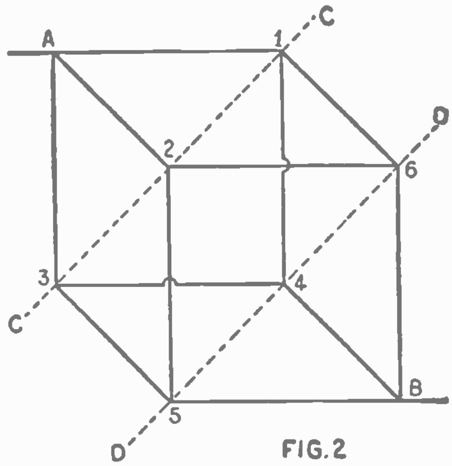


FIG. 2

Since the points connected by the dotted lines are symmetrically located in the network, they must be at the same potential and may therefore be connected without altering the joint resistance.

High Frequency Coil

(529) Henry R. Timm, Newark, N. J., asks:

Q 1 In THE EXPERIMENTER of February, 1925. I notice that in the article on the preparation of phosphine gas, by Leslie R. Raymond, there is apparently a misprint. A flask F is mentioned in the article and no flask of that letter appears in the diagram.

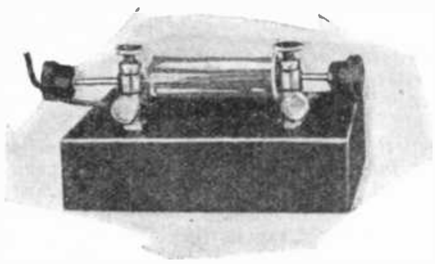
A. 1. It is a misprint and the text should read flask E. The experiment is particularly well devised, and it protects the experimenter from an explosion in the generating flask by dispelling therefrom all the oxygen of the air before the evolution of phosphine.

Q 2. In the article on experiments on high frequency currents by Lester Reukema, what is the size of the wire used on the secondary windings?

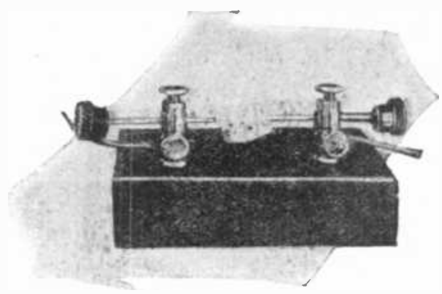
A. 2. For full dimensions and gauges we refer you to page 474 of the May issue: No. 22 copper wire double cotton covered is advised for the secondary But you will find a great many other dimensions given in this second instalment of the article.

Experiments with Ford Coils

(*Continued from page 692*)



Combustion of a piece of metal. If two pieces of fine wire are attached to the needle points with a glass tube slipped over the needles, one of them will burn as though it were some easily combustible material.



Very curious and interesting experiments can be performed with discharges passing through various crystals, copper sulphate, potassium ferrocyanide, alum, rock candy, and others.

The familiar carbide cannon is here fired electrically. The mixture of air with acetylene generated by the action of water on calcium carbide is exploded by an electrical discharge across the usual auto spark plug.

of a wire connected or better soldered to the tin of the can will insure one connection to the plug from the coil secondary; the other wire, leading from the plug binding post, is connected to the remaining secondary terminal of the coil.

The cannon may be operated by placing two or three small lumps of miner's carbide in a can, moistening with water, replacing the lid, and finally closing the switch to cause the spark to explode the mixture of air with the acetylene gas formed by the carbide and water.

The lid flies from the can with some force, making a deafening noise at the same time. The cannon is perfectly safe if common sense is used in its operation. Of course, the can should not be pointed directly at other persons, windows, etc. The lid travels only a few feet.

And so the experiments might lead on indefinitely. New ones will present themselves with the trials of those herein described. The common spark coil offers no end of profitable instruction and amusement.

The Ark of the Covenant

(*Continued from page 667*)

"But you don't know anything about me——"

"Don't I? Trust me for that. Off wi' ye!"

So he yelled at us from the side of his tanker, dancing with excitement the while. We sheered off while he waved at us, and we taxied down the roadway preparatory to taking off for our climb over the town.

The Merlin is Started at Last and Begins a Long, Hopeless Search for the Ark of the Covenant Which Has Disappeared from the Field of View

Milliken and Dan had both seen the airship, and they confirmed my idea of her direction. Soon we had left Guayaquil behind and were climbing, climbing for our flight over the Andes. The verdure of the coastal strip passed beneath us, and we rose over a still and rugged barrenness. Up, up we flew, nor did we flatten to level flight until over eight thousand meters was showing.

Banks of clouds lay far below us. To either side and in front of us stretched the mountains, their peaks glowing jewel-like in the sun—crimson, saffron, gold—their hollows and deep cañons, cobalt, purple, indigo. Range on range they stretched, scaur and hump and tooth, cleft and riven, moulded and hewn. And everywhere an awful stillness, such stillness that the steady song of the seaplane seemed sacrilege. Below us no bird floated, about us no wind stirred, except for the wind of our own speed through the bitter air.

All apertures of the cabin were closed, we had the heaters on, and we were breathing oxygen, while compressed air was being fed to the induction of the cylinders. The speed dial stood at well over the five hundred kilometers mark, and though our quarry was over an hour ahead of us, we had great hope of overtaking her.

Time passed. Danny shared the lookout with me, while Milliken rustled a meal to break our fast. When it was ready he took his share before relieving Dan, and when Dan had eaten I gave the control to Milliken and ate last of all. I wanted two pairs of eyes for the lookout all the time. Yet for all our vigil we came upon no sight of the airship. We reckoned her speed at two-thirds of our own, so that if we were in her course we should have sighted her in about two hours' flying. Two hours passed, and it seemed that she had escaped us.

We kept heading in the same direction for about another half hour, then we consulted what to do. It was decided that we cast a wide circle to the north, keeping high, so I swung the *Merlin* in a wide loop up into what must have been the southern border of Venezuela. I reckoned to describe a circle five hundred kilometers in circumference, which at the height we were flying would give us a vast area for scrutiny. We were now over the upper reaches of the northern confluents of the Amazon, and beneath us rolled endless miles of dark green-grey foliage. We saw here and there the silver gleam of water, wide rivers that thinned were lost in the foliage, and appeared again. But everywhere the dominant note was that hardly broken hue of dark grey-green. If the airship had been anywhere below us, it would have been distinct against that sombre background. But time and again the distant gleam of water would deceive us, would send us chasing at full speed, and our circle grew very ragged of outline.

The strain of flying at that height and speed was beginning to tell on us, and our constant watch had wearied our eyes—in spite of that uncanny alertness of perception which quick flight induced—so at half-past ten, when we had cast two wide circles, we voted a spell of rest, and I searched about for big enough water in which to come down. We seemed to have missed our quarry entirely.

A Strange Red Scar Upon the Earth and an Uncanny Lake. Landing in the Lake After the Search Has Been Abandoned for the Time Being. A Strange and Dreary Landscape With Dead Vegetation

Then, in the midst of that drab green monotony below us, with its endless hummocks of undulating tree tops, there came a break. From what appeared to be an area of marshland, for it was speckled with water, there rose a short incline of bush; this was succeeded by a spear of plateau rising on tawny bluffs of rock. Mighty interesting we found this plateau, for from a point north of its center line, in a widening scar, there stretched to one side of it a sudden patch of blood red. By chance, I have hit on the right word to explain this red streak. It was more like a raw scar on the face of the world than anything else. From its starting point it widened as it ran transversely over the green tableland, then began to narrow as it dropped over the bluffs on the south side, until it was lost in the green of the lower levels.

"Seems to be some curious outcrop," said Dan. "Doesn't it look sinister and cruel, somehow?"

"You've hit it, Danny," I agreed. "That's just what it does look."

Near this red streak, but separated from it by a thickening band of green, the plateau took another sudden rise in hush-hung rocky bluffs, and on this second step, as it were, there lay a wide expanse of water, under the spurs of what from the map I judged were the foothills of the Parima Mountains.

"Let's land on the lake there," said Danny, "and maybe we can get down to look at that outcrop. I'd like to see that."

The water seemed fair for landing and, what was more important, for taking off again, so I let the *Merlin* hover down gently to the face of the lake. I taxied a little on touching, then switched off, and let the way on the plane carry her until she was nosing into the trees and bushes that fringed the still water.

III

Exploration

There was something uncanny about that lake, thought it was wonderfully beautiful. The trees round it were not extremely tall, but they were straight and smooth of trunk, their branches beginning to shoot out only at a good height. These locked with the branches of the others around, until the foliage above was a thick canopy unpierced by the rays of the sun. The undergrowth was thick and luxuriant, but not nearly so high as I had thought it would be. The prevailing color was a dusty green, unbroken, unrelieved, except for the browner grey of the tree-trunks, or when some big butterflies, gaudily painted and amazingly wide of wing-spread, would flutter swiftly by.

Now and then there would come the shriek of a bird, shattering the stillness and intensifying it. I have said stillness, but it was not so much that. A weird hushed murmur clung to the place, the hum of insects, the sound of a myriad life—and under it all a mysterious deep chatter and whisper, whisper and chatter, so dead in tone as to be almost undefinable as sound. The place gripped. It almost sickened one with its intensity. And one could not tell what it was that gripped, what brought the sickening intensity. Here man was terribly puny in the face of immutable nature, and my lovely *Merlin* in her modernity was an offence.

I think my companions felt much as I did, but it wasn't a thing to talk about. We looked at each other with a sickly kind of gaiety, like a lot of boys stolen into a cathedral in prohibited hours.

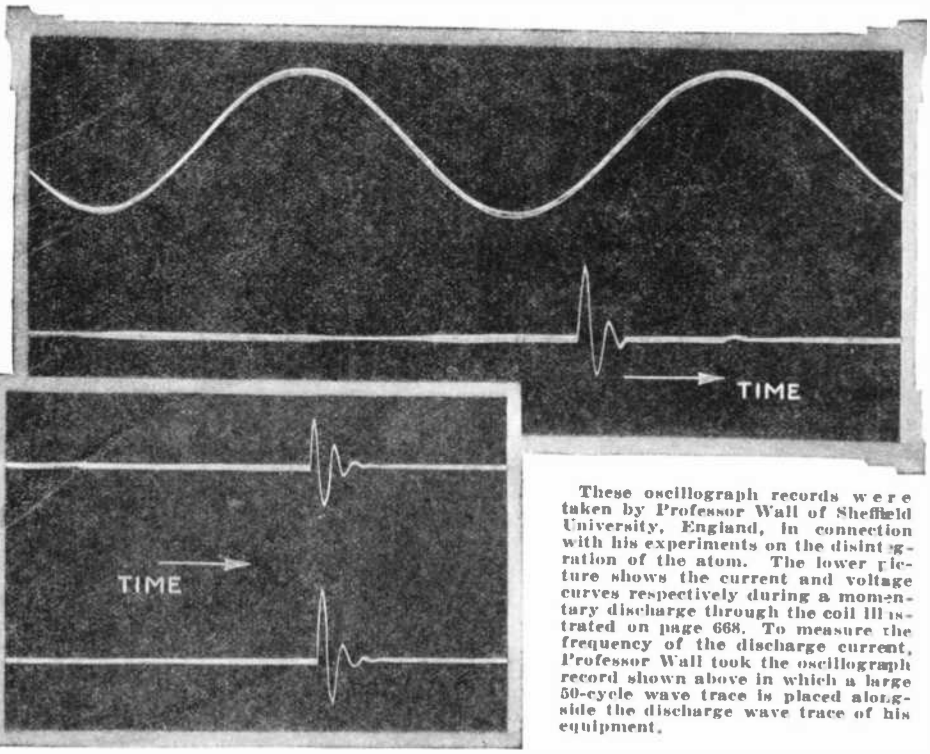
Milliken, the practical, made the first attempt to break the spell. He lit the stove and brought out the frying-pan. We had a sort of second

(*Continued on page 705*)

Intense Magnetic Fields

By Dr. T. F. Wall

(Continued from page 669)



These oscillograph records were taken by Professor Wall of Sheffield University, England, in connection with his experiments on the disintegration of the atom. The lower picture shows the current and voltage curves respectively during a momentary discharge through the coil illustrated on page 668. To measure the frequency of the discharge current, Professor Wall took the oscillograph record shown above in which a large 50-cycle wave trace is placed alongside the discharge wave trace of his equipment.

at various distances from the center. An atom of hydrogen in its natural or uncharged state comprises, for example, a nucleus of one unit positive charge and one electron revolving round the nucleus at the tremendous speed of over 1,400 miles per second. The heavier elements have a correspondingly larger net positive charge of electricity concentrated at the nucleus and in the neutral condition of the atom the number of electrons circling round the nucleus is the same as the number of net positive units in the nucleus charge. Thus an atom of the metal mercury comprises a nucleus with a net positive charge of 80 units and 80 electrons circling round it in various orbits. An atom of the metal gold has a nucleus charge of 79 positive units and 79 electrons. The magnitude of the positive charge on the nucleus is a characteristic quantity for the atom in question. *If the magnitude of the nucleus positive charge can be altered, the nature of the element itself would be changed. In other words, in order to transmute one metal into another, the necessary and sufficient condition is that the nucleus charge of positive electricity should be correspondingly altered in magnitude.*

Some rough idea of the relative magnitudes of the quantities with which we are concerned in dealing with atomic structure may be obtained by supposing that a drop of water is magnified to the size of the earth—the atoms in the drop would then appear to be approximately the size of cricket balls. The *electrons* in the atoms are almost inconceivably smaller than the atoms themselves and their relative sizes may be compared to say sparrows in the Capitol at Washington.

A great impetus to general interest in the whole subject has undoubtedly resulted from the recent dramatic announcement that Professor Miethe has been able to transmute the metal mercury into gold by passing a very intense current of electricity for a prolonged period through mercury vapor contained in an air-exhausted vessel. This discovery is all the more noteworthy as being accidental and wholly unexpected, having been made during the course of an investigation undertaken for an entirely different purpose.

According to the view of atomic structure outlined in the foregoing, it is considered that in Prof. Miethe's experiments an electron of the stream of electrons of which an electric current is formed, has penetrated to the nucleus of many of the atoms of the mercury vapor and thus, by reducing the nucleus positive charge from 80 units to 79, a number of atoms of the mercury have been transmuted into gold.

Although so far this method of producing gold would be from a commercial point of view prohibitively costly, nevertheless the accomplishment of this result is of altogether inestimable scientific importance.

The mathematical difficulties of exhaustively dealing with the calculations of the arrangements and movements of the electrons in their orbits are practically insuperable except for the case of a simple atom like hydrogen which has only one electron. It is clear, therefore, that increase in our knowledge of atomic structure will depend almost entirely on experimental work and on the developments of methods which may be capable of breaking down and building up again the atoms at will.

In order to make clear what is the general scheme of the author's undertaking, the following considerations will be of assistance. Each electron circling round in its orbit in the atom is, in effect, an electric current of very great strength and consequently gives rise to a very intense magnetic field within the atom. The order of magnitude of these inherent magnetic fields in the atom is something like one hundred million gauss, and this is far and away greater than that of any magnetic field which has yet been produced artificially. If, however, it is possible to impress on the atoms an artificially produced field of an intensity comparable with that of the inherent magnetic fields due to the rotating electrons, it will be possible in this way to affect the motion of the electrons so that they may either be driven towards the nucleus or dragged away from it. *Now if one or more electrons could be driven into the nucleus, the nature of the element of which the atom is part would be changed and an entirely different element would in consequence appear. If on the other hand electrons can be driven from an orbit near the nucleus to an orbit near the boundary, it is highly probable that a large amount of energy would thereby be released.*

These considerations then form the basic idea of the author's experimental undertaking, and the characteristic features of the plan include the following three essentials:

(1) A new means for impressing very intense magnetic fields on the atoms of the materials under investigation.

(2) The use of a *magnetic* material for the substance under investigation.

(3) Means for repeatedly impressing the intense magnetic fields on the substance under test so that an accumulative effect may be produced.

Perhaps the most obvious method of producing an intense magnetic field would be by the use of an electro-magnet excited by direct current. This method, however, is subject to very severe limitations and as far as the writer is aware it is impracticable to produce in this way magnetic fields of an intensity greater than about 100,000 gauss, owing largely to the heating difficulties which would be experienced with the exciting coils.

The method used by the author is to charge a number of high voltage static condensers of very large capacity and then to discharge them through a small solenoid within the core of which, the specimen under test is placed (see Fig. 4). By suitable design it is possible in this way to obtain extremely heavy currents in the solenoid winding. Further, since the currents are oscillatory and persist only for a small fraction of a second, the wire of the solenoid can be of very small section without danger of the solenoid being burnt out. For example, if the solenoid is wound with copper wire of No. 20 S.W.G., the diameter of the wire will be 0.036 inch and the normal current carrying capacity is only about 4 amperes. It is nevertheless possible to obtain from the static condenser discharge a *current of many thousand amperes* through the coil without serious risk of burning out the turns.

As a numerical example, suppose the solenoid is wound with 100 turns per centimeter length and that the first peak value of the condenser oscillatory discharge current is 5,000 amperes. In accordance with a well-known formula the intensity of the magnetic field which will thereby be produced at the central part within the core of the solenoid will be

$$\frac{4\pi}{10} \times 5{,}000 \times 100 = 630{,}000 \text{ gauss.}$$

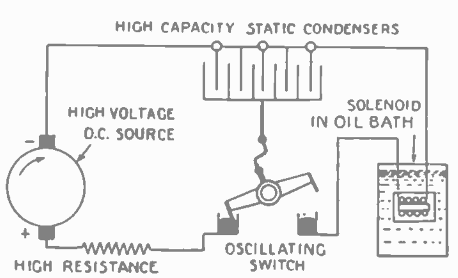


FIG. 1

A diagram of connections of Professor Wall's apparatus. By means of the oscillating switch, the high capacity condensers become alternately charged by the generator when discharged through the oil immersed coil.

In Fig. 1 is shown the general arrangement of the apparatus. The solenoid is immersed in a tank of oil which not only facilitates cooling, but also greatly improves the insulation of neighboring turns when the high voltage condensers are switched on to the solenoid. The condensers are charged from a high voltage direct current source, for example, a wireless dynamo or a battery of accumulators. A buffer resistance is included in the charging circuit to prevent the excessive rush of current during the initial stage of charging, that is, when the condensers are empty or nearly so. A motor driven oscillating switch is arranged with mercury cup contacts so that when the switch arm is over at one side the condensers are placed on charge, and when the switch arm moves over to the other side the charged condensers are connected to the solenoid and thus discharged through the solenoid winding.

One of the greatest difficulties encountered in the course of this work is the necessity for providing means to prevent the solenoid coil from bursting when the enormously large discharge current passes through it. As is well known, when a current passes through a solenoid a mechanical force is developed between neighboring turns which tends to draw the turns closer together. When dealing with the normal values of current usually met with in practice, the magnitude of this mechanical force is so small that its effect is generally negligible. In the case, however, of the currents produced in these experiments, *the mechanical forces may be of devastating effect.*

The coil turns are drawn towards the center of the solenoid bobbin and the wire is thus stretched, the increase of diameter of the central part of the coil being usually sufficient to rupture the wire unless special precautions are taken to counter the effect. Consequently, the circuit is broken under the oil, a violent explosion takes place and serious damage may result. As an example of this effect, the photograph given in Fig. 2 has been prepared. At the top right-hand corner is shown the newly wound coil on an ebonite bobbin and over the finished coil is fitted a sheath of *lignum vitae* wood which is intended to prevent the movement of the turns of the coil under the mechanical forces developed. A test soon showed, however, that such a sheath was not strong enough for the purpose. After the condensers had discharged through the coil under considerably less than the full power, the sheath burst into fragments and the coil was shattered into individual rings as shown in the photograph.

It became essential then to design a form of sheath which would be able to withstand the greatest mechanical forces which would be developed when the condensers were discharged under full power. After a good deal of preliminary work it was decided to build the sheath of steel and Fig. 3 shows a photograph of the sheath assembled in position, the ends of the coil being brought out through insulated bushes as shown. In Fig. 4 the component parts of the sheath and the coil itself are shown.

As an example of the order of magnitude of the mechanical forces which may be expected under the conditions of these experiments, the following data will serve, viz.:

If a conductor carrying a current of i amperes is situated in a magnetic field of intensity H gauss, the mechanical force developed on each centimeter length of the conductor is given by the formula

$$\frac{H \times i}{10} \text{ dynes.}$$

Otherwise stated, the force *per inch length* of conductor will be

$$\frac{5.7 \times H \times i}{10^7} \text{ pounds weight.}$$

If $H = 700{,}000$ gauss, and $i = 3{,}000$ amperes, the mechanical force acting on the conductor is

1,200 Pounds Weight Per Inch Length

Reference to Fig. 4 will show on the table in the foreground of the picture a small tube of magnetic material, that is, steel. This is the sample which is being subjected to the intense magnetic fields developed within the solenoid core. The magnetic characteristics of this sample are carefully determined before the test. The sample is then inserted in the hollow core of the solenoid and a large number of condenser discharge currents sent through the coil at intervals. The sample is then removed and its magnetic characteristics again carefully determined and compared with those originally found.

This then is the third characteristic feature of the undertaking, *viz.*, the sample is subjected to a large number of applications of the very intense magnetic field. In this way it is expected that a cumulative effect will be obtained so that, although the intensity of the impressed field may be considerably less than that of the inherent magnetic fields within the atom due to the revolving electrons, it is expected that the repeated applications will produce a cumulative effect and eventually result in a pronounced disturbance of the electronic orbits. It is reasonable to suppose that any such disturbance will manifest itself in a pronounced change in the magnetic properties of the sample, and it is for this reason that a magnetic substance has been chosen for the material of the test piece.

In Fig 5 is shown an oscillogram of the current discharge through the coil and the corresponding alternating pressure wave at the terminals of the coil. The upper wave is the pressure wave and the lower one the current wave.

In Fig. 6 is shown an oscillogram of the same current wave as that shown in Fig. 5, but in addition, in the upper part of Fig. 6 is shown a 50 frequency wave, the purpose of which is to provide the time scale (that is, the oscillation frequency) for the condenser discharge current wave.

In Fig. 7 is shown a photograph of the general arrangement of the apparatus. The solenoid is immersed in an oil tank placed in the containing vessel shown on the table. The reason for using an outer containing vessel is to catch the oil in case the oil tank bursts under an explosion through a breakdown of the solenoid coil. The oscillograph, by means of which photographs of the current discharge waves are obtained, may be seen on the extreme left of the picture.

Although the tests have not yet been in progress sufficiently long to obtain any complete data as to the influence of the intense magnetic fields on the sample, the tests have shown that *a decided change in the permeability of the sample has been effected.* Owing to repeated breakdowns of the apparatus, the progress of the tests has been much impeded, and it has been necessary to redesign some of the details in order that the extraordinarily great stresses developed in these tests may be successfully withstood. It is considered that most of the difficulties have now been overcome and in consequence rapid advance towards definite and conclusive results may now be expected. The work is necessarily of a very arduous and exhausting character, but the writer has the greatest confidence that the undertaking will soon produce results of an exciting nature.

The Ark of the Covenant

(*Continued from page* 703)

breakfast, and then Dan and I clambered ashore, leaving Milliken, who would not be persuaded to leave the *Merlin*, to keep watch and ward.

For our adventure, Danny and I took with us an automatic apiece, and a pocket compass. Both of us had flying-boots on, so we felt safe enough about snakes, which were all we thought we had to dread. It seemed impossible that there could be any human beings in that wilderness.

We pushed our way westward through the undergrowth, making for the bluff that overhung the plateau of the red scar, and although the going was heavy, it was not superlatively difficult. With half an hour of scrambling we were on the bluff, and the oppression of the dark forest left us as we breathed the sweet air of its edge. Down below us lay the tableland, perhaps forty meters beneath, and we could see the red outcrop plainly. Water lay on either side of the plateau; to the south a winding river with a creek running up to the cliff of the highland, and to the north a small lake we had barely noticed in our approach by the air from the south. This lake was drained, it seemed, by another winding river that ran through a little gorge into the marsh-land surrounding the toe of the plateau. We found a place where the limestone was not so sheer, and a way down that promised a fairly easy return.

Trees hugged the base of the bluff, but we soon were quit of them as we worked towards the red scar, for they thinned out until we were among bushes of the nature of myrtle. As we got nearer the outcrop, even these myrtles thinned, until they were far apart and strangely stunted in growth. Then our feet crunched on the red earth.

To me that earth seemed to be living! I felt the hair prickle on my scalp, and I had a foolish impulse to jump back to the blacker—and somehow *cleaner*—soil!

"Nothing grows on this red stuff" whispered Dan. "See, Jimmy, there's not a plant or a blade of grass on it, and look how these myrtles are thinned and stunted until they are away back from it!"

"Let's get off it, Danny," I said. "I don't like it."

"You feel that too " he muttered. "I suppose it's the desolation of it, but I have just the same feeling."

"Let's work round it, then," I said.

Danny did not seem to hear me. He was frowning at the earth and scrabbling amongst it speculatively with the toe of his boot. He turned over a piece of rock and stooped to pick it up. When he straightened himself his face was red, but the color came from some suppressed excitement.

"Look at this, Jimmy," he said, holding out the rock. "Do you know what it is?"

It was a cindery kind of rock, blue-black in color, with facets that shone faintly, and a dusty layer, saffron to deep rose in tint, clung to a side of it. I had never seen rock like it before.

"No," I said.

"I'll eat my hat if this—the red stuff—isn't rhodolite," said Dan, his eyes dancing.

"Well?" I said pettishly, for I wanted to be off that red muck.

Rhodolite, the Great Radium Ore, Is Discovered. The Death of All Vegetation in the Neighorhood Accounted For

"Rhodolite, Jimmy," Dan said solemnly, and there wasn't so much of the boy about him now. "Rhodolite is one of the most highly radio-active ores that have been discovered. Small quantities of it have been found in Africa and, I believe, in Peru. I have had pieces of it in my lab.—but nothing nearly so good as this!"

He crouched down now, letting the red stuff dribble through his fingers.

"I have a hunch," he said, "that all this scar is highly radioactive. That explains why nothing grows on it. See how the trees avoid it, how the bushes close to it are poor and almost withered. Yes. Let's get off it, Jimmy. The thing's alive!"

We made our way back to the decent earth, and worked northwards round the end of the red scar. We were a strangely silent couple then. Dan had lost his boyishness, and his face had a queer expression of power. I was getting a flash of the Daniel Lamont who could add so many letters to his name, the Daniel Lamont whose word went with the leading scientists of the day.

We trudged through the undergrowth in a nor'westerly direction, making for the edge of the plateau that overhung the little lake we had seen from the bluff above. With my heavier bulk, I broke the trail, my friend coming after me. I don't suppose we had been laboring twenty

(*Continued on page* 710)

The Experimenter's Bookshelf

A Quantitative Study of Electrical Apparatus

GENERATOR AND MOTOR EXAMPLES. By Professor F. E. Austin. 108 pages. Published by the author. 1924. $2.50.

Engineering success depends largely on two essential characteristics of machines, the quantitative and the qualitative. Knowledge of the qualitative characteristics enables one to make the machine operate; while knowledge of the quantitative enables one to calculate "how much" a machine will do, or what its efficiency of operation will be. In this little volume the author aims to consider qualitative phenomena and principles as well as quantitative results with their relations as regards efficiency.

In commercial enterprises wherein electricity is adopted as a means to effect a certain desirable result, the ultimate efficiency to be considered is a financial efficiency; a complex quantity made up of numerous partial efficiencies as mechanical efficiency, electrical efficiency, power efficiency, plant efficiency, line efficiency; each of importance in the attainment of a high financial efficiency.

A careful study of the subject matter here presented will enable one to apply the fundamental principles in many cases of engineering. A firm grasp of fundamentals should be the aim of every student. It is believed that the greatest educational benefit along technical lines may be realized by careful and consecutive study of the problem presented.

An interesting feature developed in the book is the important but little known principle that maximum power output is obtained from a separately excited generator when the resistance of the load is exactly equal to the armature resistance. This principle has application also to radio: the maximum output from a plate circuit is obtained when the output impedance, that is, the impedance of the transformer or telephone receiver is exactly equal to the internal impedance of the tube.

The treatment of these problems in this book involves a considerable amount of mathematics. In some cases differential calculus is employed.

Practical Study of Direct Currents

HANDBOOK OF DIRECT CURRENTS. By K. C. Graham. 164 pages. Published by Simmons-Boardman Publishing Company. 1924.

The purpose of this volume is to impart a knowledge of the fundamental principles of direct current theory with a minimum expenditure of time and effort on the part of the reader. Many books have been written about this broad subject, but it seems to be characteristic of most that they either presuppose too much knowledge on the part of the reader or on the other hand describe and explain in such detail that the main points of the subject are obscured or entirely lost in a maze of words. Neither of these methods is conducive to self-instruction and the author has endeavored to strike the happy medium between them.

The material has been arranged in a logical manner beginning with the most elementary concepts of electricity and preceding by easy stages with the more technical phases of the subject; the book has been divided into fourteen parts or chapters, each one of which deals with a specific branch of the theory, but all of which are nevertheless inflexibly bound one to the other. The student who conscientiously studies each chapter should have no difficulty in comprehending the innumerable phenomena which constantly present themselves in electrical work.

History and Theory of Electricity

WHAT IS ELECTRICITY? By Hanns Günther. 102 pages. Kosmos Company of Nature Lovers. Stuttgart, Germany.

The Germans have a faculty of producing most attractive little manuals in different branches, and this one in its hundred pages and its 13 chapters gives a very entertaining resumé of what we think we know. The most lucid comment on it could be expressed in the words of Alexander Pope, "True wit is nature, to advantage dressed. What oft was thought but ne'er so well expressed." Many of the pictures will be familiar to our readers. When we note the fact that telephony is covered in half a dozen pages, it will be seen how short the book inevitably is. But the picturesque illustrations, the nice little abstract which precedes each chapter and the general features of its production make us recommend it to our readers who read the German language. It contains a very adequate index, a note of the books used in compiling it and a table of contents. The illustrations are quite numerous.

A $100,000 Chemistry Prize

THE opium evil, it is said, could not be obliterated by direct Governmental action, at least in India, without exciting revolution, the people are so dependent on the cultivation of the poppy for their agricultural occupation.

A well-known manufacturing chemist of New York City, Dr. Herman A. Metz, offers a prize of $100,000 to anyone who will evolve a process for manufacturing opium in the laboratory. The offer is not so rash a one as it seems on the surface, for opium is a very complex substance; it is a mixture of a number of chemical compounds.

The idea is that if synthetic opium can be made, it will be far cheaper than is the present product of the poppy plant, and cheapening the product will eventually do away with the entire poppy-raising branch of agriculture and the synthetic product can be readily subjected to the most exact Governmental regulations.

Two of the most famous vegetable dyes of the world were Turkey red and indigo. They represented enormous branches of agriculture, but synthetic substitutes were found; both are now manufactured in the chemical factory, and the old-time fields are given to other plants. The basis of homeopathy is that like cures like, and this certainly is an effort to evolve a homeopathic cure of an evil.

The Metz Prize

A NEW weapon is sought to fight the great evil of opium addiction. The sum of $100,000 awaits the producer of the weapon. And the weapon is nothing more nor less than opium itself. But—here's the rub—the opium must be produced in the laboratory of the chemist, instead of in the seed-head of the poppy. In other words, it must be synthetic opium, instead of natural opium. Nor will a substitute drug having the same properties answer; the synthetic opium must have exactly the molecular structure of the original. The offer is made by Herman A. Metz, former Controller of New York, under condition that the winner relinquish his rights to the process and allow it to be used under conditions arranged by an international agreement. The aim is to wipe out the poppy-growing industry of the Orient, by underselling the natural product, thus—it is hoped—making it possible to control the traffic. The New York *Sun* quotes Mr. Metz as saying that the idea of offering the prize occurred to him after listening to an address by Dr. Carlton Simon, in which he suggested that the discovery of a method of making opium would be the best method of attacking drug addiction. This explanation follows:

"Dr. Simon advanced the theory yesterday at the international police conference that the opium problem could be eliminated from international politics only by dealing a death-blow to the commercial interests now engaged in the industry. Great Britain would stir up a revolution in India, he said, if an effort were made to prohibit opium-growing there.

"But if a synthetic opium were produced, the growing of the opium poppy would become uneconomic. It would be gradually wiped out as the growing of indigo was wiped out by the manufacture of synthetic indigo. The growers of the opium poppy would be forced into other branches of agriculture, and the opium complex in international politics would become a thing of the past. Then all nations could unite on a program with the object of eradicating the opium habit.

"There is no reason in the world why it should not be produced synthetically.

"Dr. Simon, when informed of the offer of Mr. Metz, said he believed chemists would be stimulated to work on the problem, and that as a result the worst of the opium evil would be stamped out.

"'The synthetic process of manufacture could be regulated by the Government,' he said. 'The cheapened price would make it impossible for the opium plantations to continue. The profit would be taken out. Then the regulation of the evil will become easy.'"

Preparation and Properties of Hydrogen Peroxide

(*Continued from page 686*)

some dilute sulphuric acid add a few crystals of potassium bichromate and shake to dissolve. Then add some ether and some peroxide. A blue ethereal layer will appear. This blue compound has never been isolated because when the ether is evaporated, the compound decomposes. This test is very sensitive; one part of peroxide in 80,000 parts of water will be indicated.

The Tungsten Arc Lamp

(*Continued from page 658*)

starts arcs between the bridge wire, as it may be termed, and the electrodes, and as the distance increases the arcs spring across between the two electrodes proper and the bridge wire ceases to act, as long as the lamp burns, being kept at a distance from the electrodes. Fig. 5 shows this lamp.

The disc-shaped bridge piece contains in its supporting pillar or rod a compound metal bar, that is heated when the current is turned on by a current passing through a tungsten spiral. This makes it move and draws the bridge piece back from the electrodes. The lamp uses about one ampere of direct current and about 1.3 amperes of alternating current; it therefore is superior for alternating current to the lamp just described, as for equal potential and equal light only half the current is required.

The tungsten arc lamp in the present state of the art is not adapted for everyday lighting. Its great utility is for those places where a very small area of lighted surface is necessary, and one of greater and more evenly disposed superficial brightness than obtains with the usual lamp, especially for optical apparatus of various kinds.

Lately the tungsten arc lamp has been applied to other purposes than lighting, namely for the rectifying of alternating currents and for changing direct current into alternating current.

(*Translated from Die Umschau*)

EXPERIMENTER'S PATENT SERVICE

EDITED BY JOSEPH H. KRAUS

ON this page every month we will give our readers the benefit of our experience on patents and questions pertaining to patent law. Years of our treatment of the subject of patented, patentable (and many unpatentable) devices has proved satisfactory to hundreds of thousands of experimenters. The writer, who has handled the Patent Advice columns of SCIENCE AND INVENTION MAGAZINE for the past seven years, will answer questions pertaining to the experimental side of Patents in this publication. If you have an idea, the solution of which is puzzling you, send it to this department for advice. Questions should be limited to Electrical, Radio and Chemical subjects. Another of our publications, SCIENCE AND INVENTION, handles patent advice in other branches. Address "Experimenter's Patent Service," c/o The Experimenter, 53 Park Place, New York City.

Electrical Gas Flame Starter

(12) R. A. Waters, Chicago, Ill., asks whether we believe there would be a market for a painter's gasoline torch started by electricity. The device is to be used for starting gasoline fires of corn poppers used on the beaches.

A. Supposing that you could start these gasoline torches by heating up the tip of the burner by means of electricity. What advantage have you gained? None as far as we can see. You might, if you intend to use electricity, substitute an electrical heater for the entire gasoline device and do away with the noise, smoke, flame and danger of fire which you evidently attempt to overcome. Using an electrical corn popper would make toward greater cleanliness, although such corn poppers are already on the market, yet you could not protect such an idea.

The reason that gasoline blow-torches are used in some corn poppers is because these corn poppers are moved about from place to place. Sometimes such corn poppers are less expensive to maintain and operate than electrical devices of similar nature. In some towns, however, electricity is very cheap. In these latter mentioned places, electrical corn poppers would have an advantage over the gasoline types. To the best of our belief, a heating coil fitted to a gasoline torch would have such a very limited use that a patent upon the idea would seem to be worthless. We do not suggest that you apply for one.

Refrigerator

(13) A. N. Nevers, Ottawa, Toronto, Canada, has submitted a drawing of a refrigerating system in which ordinary ice is used, but the doors of the icebox are sealed tightly and compressed air is pumped into the refrigerator. He reasons that the device should work as a thermos bottle.

A. You evidently do not understand the principle of operation in a thermos bottle. The space between the two walls of the bottle is not filled with compressed air as you suppose, but as near a true vacuum as it is possible to produce practically. Filling the space between the walls of glass in a thermos bottle with compressed air would circumvent the original theory of its operation. It would, therefore, be useless for you to add the electrically-driven air compressor to your icebox. From another standpoint, your suggestion is impracticable. Air is considerably heated during the process of compression. This heat must be removed by the ice in the icebox before the air can be cooled enough to affect the food. We do not suggest that you work upon this idea to any extent.

Spark Plug Intensifier

(14) P. R. Montague, Springfield, Mass., writes:

Can I secure a patent on a spark plug and intensifier for automobile engines in which the intensifier is a series gap with an adjustable rod passing through the top of the spark plug fitted with a threaded end, so that the same may be regulated by employing an ordinary screw driver for controlling the size of the spark gap?

A. You might perhaps be able to secure a patent on this combination spark plug and intensifier on a technicality. No basic patent could be granted on the same because the idea is very old. There are at the present time a number of concerns manufacturing spark plugs of an almost identical nature.

Spark plug intensifiers, although in vogue several years ago, are diminishing in popularity very rapidly now, and we believe that in a few years no automobile sales and service bureaus will stock these.

If you will walk into the average five-and-tent-cent store, you will find spark plug intensifiers sold there. These intensifiers may be attached to any desired spark plug and are not integral with the device.

Such attachments we believe are superior to the plug containing the series gap as designed by you. We do not suggest applying for a patent on the system.

The Ark of the Covenant

(*Continued from page 705*)

minutes before we were on the edge of the plateau.

Below us lay the little basin from which ran the winding stream, but because of the configuration of the cliffs and their overhang, our view was not very good. Half the basin was cut off from sight by a ridge that ran out from the side of the plateau.

"There's a mighty funny air about that place down there," Danny whispered, when we had looked in silence for a minute or two. "What is it, Jimmy?"

"I don't know, Dan—unless it is that it's a little too trim for its surroundings."

"I think you've said it, Jimmy. Wouldn't you say that the neck of the basin has been widened? Or else why are the river banks there so sheer, when at other places they're undercut or fallen in?"

"Spades?" I whispered.

"I'd say so."

"Niggers?"

"Not the kind of thing niggers would do."

We discovered a growing suspicion in each other's eyes.

"What do you say to crossing the plateau to the other side," I asked softly, "and seeing what's there? Does it strike you, Danny, that the little lake below must be filled from somewhere—or else how do you explain the steady current into the river?"

"That strip we took to be a creek on the other side—maybe it flows under the plateau," said Danny. "Let's investigate, anyhow."

We turned south and began to work down the west side of the scar. For a space the going was heavy, but after a little the undergrowth began to be less dense. The plateau seemed to be about a kilometer wide, perhaps more, so with the heavy going at the start of our crossing the journey looked like taking us about half an hour. I wanted to clear the thing up, get back to the *Merlin*, and be in Maracaybo by nightfall. It was now long past noon, somewhere about half-past one, and the heat was oppressive. We had to make our way back over the red outcrop, climb the bluff, and find our trail through the forest to the lake above and the *Merlin*. My suspicion had died down. The whole place was so desolate and lonely, so silent, that to think we were somewhere in the neighborhood of the raiders' lair seemed too far-fetched. I was anxious to be on the chase again.

Danny, however, had some idea in his head. He was plugging along by my side with an alertness and keenness that I was at a loss to account for, so after a long spell of silence my curiosity got the better of me. I turned to my friend and stopped him.

"Come, old man," I said. "Out with it! What's in your mind?"

"Honest, Jimmy," he said, "I don't know. I'm just a lump of suspicion—that rhodolite, you see. I've got it sort of mixed up with radium——"

"You mean——?"

"Yes. Confound it, Jimmy! We've got to account for all that radium somehow——"

I gazed at him for a second or two.

"All right, Dan," I said. Let's go on—but if there's anything in it, we're too far away from the *Merlin* to be comfortable."

We went on. I now caught more than a touch of Danny's excitement and alertness. We were pressing south, a little westwards, when suddenly we caught a gleam of something high and white among the grey-green of the foliage, and towards this gleam we cautiously threaded our way. Presently we were near enough to see that the whitish gleam came from a number of conical stone spikes standing high among the bushes.

"Sinter cones," whispered Dan, "like those of Hammam Meskoutine in Tunis."

"Dried-up hot spring?"

"Yes. A gradual crystalline precipitation building up into a hollow cone."

"Mighty queer plateau, Dan——"

"It *is* a mighty queer plateau, Jimmy," he interrupted. "Just take a look at the peak of that middle cone. What would you say that shimmering haze was?"

"Heat, by hookey! It's a kind of chimney."

"Gimme a leg up, Jimmy," whispered Dan, "and let's see what kind of heat!"

We trampled through the undergrowth to the side of the middle cone, and then I helped Dan to climb up to the top. He put his head close to the mouth and sniffed cautiously. Then he turned round and down to me with a face livid with excitement.

"Oil-burning, Jimmy!"

I let him slide to the ground.

"Don't you see what it means, Jimmy?" he cried. "There's something doing underground! It's the smell of petroleum! By Christopher, Jimmy, I believe we've tracked them!"

"Exactly," said a familiar voice behind us. "Put up your hands, Messrs. James Boon and Company! We rather expected you'd be dropping in one day."

We turned in a hurry, to find ourselves looking down the muzzles of three rifles projecting from the bushes. Then behind a pistol in front of us the bushes parted. A big man rose up to his full height, still covering us. It was Commander Seton!

(End of Book One)

BOOK TWO

The Plateau of the Red Scar

Here Begins the Narrative of Sholto Seton, D.S.O., D.S.C., Chev. Legion d'Honneur, Etc., Commander, R.N.

CHAPTER ONE

The Litter in the Clearing

I

If patience and determination have brought readers thus far in a particularly haphazard and ill-knit story, apology from me for taking them back three years will be superfluous. Pertinacity so singular—though it be grown but from an irritated desire to finish a penance—will find nothing daunting in even so drastic a backward leap. Yet, by way of apology for the retracing, I am fain to say this much. If I am to achieve reasonable accuracy in my share of the history, and if I am to make myself properly understood by the patient reader, I can do no other.

Captain Sholto Seton, With Distinguished Titles, Introduces Himself to the Readers and Begins His Story

In the matter of introducing myself, the flattering analysis of my character, and the slight sketch of my history, given by Major Boon in his narrative, like the wound of Mercutio, though they are "neither as deep as a well nor as wide as a church door," they will "serve." Indeed, they must serve, *faute de mieux*, since I have wasted much breath and time in urging Boon to alter them or delete them altogether, and I cannot begin here to give my own version.

In justice to myself and you, I am compelled to say, further, that the pen is a most unfamiliar implement to me; my wildest hope is that I may spin a plain yarn. True, I have gained a measure of courage for my task through watching the airy insouciance with which Boon has been pounding out chapters on his typewriting machine, and I tell myself that if he can be without bowels of compassion for his readers, so, surely, can I. As I go along I shall try to vamp something of a technique from him, and from other great writers, and so win through with what credit I may.

Adventures on the Rio Negro, a Far-Off Tributary of the Upper Amazon

Three years, then, before that morning in March when the *Ark of the Covenant* dropped silently from the skies upon the financial center of New York, I was, with two ex-petty officers of His Majesty's royal navy and a handful of Indian bearers, among the upper reaches of the Rio Negro, that northern tributary of the Amazon. Of the reasons and the urges which took me into such an isolated and labyrinthine tract of wilderness I shall say little. They are personal, and might easily be tedious. I was seeking what I might find in unexplored country.

Higgins, Grumstock and myself came upon many things of a strange nature in that wilderness, but by far the strangest thing that happened to us was the finding of him whom we afterwards were to know as "The Master."

It was towards nightfall of a teeming-hot day We were about to make camp by the side of an unnamed river, tributary to the Negro, and were looking for some place suitable, when suddenly we broke into a small clearing in which were the remains of a recent camp. So recent, in deed, were these remains, that there, where a night's growth will obliterate anything but the deepest of man's handprints, the undergrowths were still trampled and awry. About the clearing empty boxes with smashed lids were scattered, and these brought to the scene such evidence of haste and confusion that interest was at once deeply stirred. I knew of no party ahead of my own, nor was there wind of any coming down from the borders of Venezuela or Colombia. It was unlikely in the latter case that the explorers had passed us, since it was improbable that they had crossed unnecessarily to the other side of the river, or had strayed far from its bank.

From the indications around we were forced to the sinister conclusion that the former occupants of the clearing had been attacked by Indians. No sane explorers would have indulged in the frenzy of breakage or the partition of stores which was shown. I resolved, therefore, with the help of my two men to arrive at what solution I could of the mystery.

As a preliminary to the search, we made camp then and there. The bearers were ordered to unload and pile stores. Higgins and Grumstock, avid for anything which promised a break in the monotony of weeks of toilsome journeying, quickly had the tents erected, and, with that unfailing *lingua franca* by which the British seaman makes himself everywhere understood, badgered and cajoled the Indians into unheard-of activity.

A Strange Patient and His Convalescence; Revelations Beginning to Come to Light, Although the Mystery Grows

Our search was not of long duration. A sudden shout took me hurrying back from the side on which I had started investigations to the other, and here, a little way deeper in the forest, I found my two men in awed contemplation of a roughly-made litter, which was slung at a fair height between two trees. In this litter a white man lay, to all appearance dead. He was a small man, and my two helpers had no difficulty in unhitching the litter from the trees or in con-

To Practical Men and Electrical Students:

Yorke Burgess, founder and head of the famous electrical school bearing his name, has prepared a pocket-size note book especially for the practical man and those who are taking up the study of electricity. It contains drawings and diagrams of electrical machinery and connections, over two hundred formulas for calculations, and problems worked out showing how the formulas are used. This data is taken from his personal note book, which was made while on different kinds of work, and it will be found of value to anyone engaged in the electrical business.

The drawings of connections for electrical apparatus include Motor Starters and Starting Boxes, Overload and Underload Release Boxes, Reversible Types, Elevator Controllers, Tank Controllers, Starters for Printing Press Motors, Automatic Controllers, Variable Field Type, Controllers for Mine Locomotives, Street Car Controllers, Connections for reversing Switches, Motor and Dynamo Rules and Rules for Speed Regulation. Also, Connections for Induction Motors and Starters, Delta and Star Connections and Connections for Auto Transformers, and Transformers for Lighting and Power Purposes. The drawings also show all kinds of lighting circuits, including special controls where Three and Four Way Switches are used.

The work on Calculations consists of Simple Electrical Mathematics, Electrical Units, Electrical Connections, Calculating Unknown Resistances, Calculation of Current in Branches of Parallel Circuits, How to Figure Weight of Wire, Wire Gauge Rules, Ohm's Law, Watt's Law, Information regarding Wire used for Electrical Purposes, Wire Calculations, Wiring Calculations, Illumination Calculations, Shunt Instruments and How to Calculate Resistance of Shunts, Power Calculations, Efficiency Calculations, Measuring Unknown Resistances, Dynamo and Dynamo Troubles, Motors and Motor Troubles, and Calculating Size of Pulleys.

Also Alternating Current Calculations in finding Impedance, Reactance, Inductance, Frequency, Alternations, Speed of Alternators and Motors, Number of Poles in Alternators or Motors, Conductance, Susceptance, Admittance, Angle of Lag and Power Factor, and formulas for use with Line Transformers.

The book, called the "Burgess Blue Book," is published and sold by us for one dollar ($1.00) per copy, postpaid. If you wish one of the books, send us your order with a dollar bill, check or money order. We know the value of the book and can guarantee its satisfaction to you by returning your money if you decide not to keep it after having had it for five days.

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veying it to the nearest tent, my own, as it happened. Under the powerful light of a petrol lamp I made examination of the stranger, and I found his heart, though scarcely discernible, was still beating.

Even with that rough-and-ready medical knowledge which I have, it was plainly manifest to me that collapse had followed fever and partial starvation, and I began to administer gentle stimulants and easy nutritives. My labor was rewarded by a slight strengthening of the heart-beat, but there were no signs of returning consciousness.

I stripped the man to put him into clean linen, and I was horrified to find that his body was terribly burned. A great patch on the left side was deeply raw and inflamed, and—most nauseating feature of all—the left hand seemed to have been burned off from above the wrist. It was a marvel that the man remained alive. These were injuries which I despaired of treating adequately from my little medicine chest, and I should have been completely at a loss what to do had the stranger not had the means of treatment with him. In the litter whereon he had been lying we found, beside a wash-leather bag apparently containing geological specimens, a large pot of reddish ointment, clean and fresh. I could find faint traces of this ointment on the fair skin around the burns, and I thought the wisest thing in the circumstances was to continue the use of it. I took clean strips of medicated linen, and with loose bandages of these I applied the ointment to the dreadful wounds.

It was two days before the man opened his eyes. We had not attempted to break camp, and our stay in the clearing had been without event. The return to consciousness was abrupt. I went into the tent to see how the patient was progressing, and found myself gazing into the mildest pair of blue eyes I have ever seen. Mild though they were, yet something lay in their depths that one met with a shock almost physical.

"What is your name?" the stranger asked levelly.

"Sholto Seton," I replied.

"An explorer?"

"In an amateur way—yes."

"How long ago is it since you found me?" he demanded.

"It will be forty-eight hours ago at seven this evening. You were in a litter slung between two trees."

"Yes. I made my bearers put me there. What day of the week was that—Monday?"

"Monday," I said.

"Yes. This is the third day of the sun since I became unconscious. It was on Monday that my bearers deserted me. You were in the nick of time, Mr. Seton—am I right in the form of address? You have the look of authority that comes from command."

"I am by courtesy Commander Seton—lately of the British navy," I replied. "But do you think you should talk, sir?"

"I shall finish in a moment," said this strangely self-contained patient. "With what have you been treating me?"

I explained what I had done.

"Excellent. Now, Commander Seton, I am afraid I must draw on your patience and good-nature to the extent of relapsing into unconsciousness for another day. Continue the treatment—especially the ointment, which you must not attempt to vary in any way. It is adequate in itself. Thank you. And until this time to-morrow, when I shall waken in complete command of myself—good-day!"

He closed those remarkable eyes of his, and was asleep. I was left with the impression, despite his utmost frality of physique, of a personality nigh ruthless in dominating will-power, a personality which gripped with hoops of steel, and of a courage, in the face of what must have been agonizing pain, which nearly appalled.

For the space of ten minutes, I think, I stood where I was. Then I tiptoed over to look down at him. He had not fallen asleep. He had relapsed back into a state of deep unconsciousness.

I marked the broad brow and deep head of the thinker, the exquisite placing of shapely ears, the fine setting of the eyes, the clean chiselling of the nose. Through a thin brown beard and moustache could be seen a mouth in shape at once firm and mobile. It was a head in a million, satisfying one's senses with both beauty and power. In spite of the luxuriance of his fine brown hair, I judged him to be from fifty to sixty years of age.

I stole from the tent.

II

The Stranger, Now Called the Master, Lays Bare His Plans to Stop the War. He Has Found the Power There Near Where the Merlin Is Resting

He recovered as I have seen a boxer between rounds recover, deliberately. He rested, deliberately relaxing until he was ready to stir, and it was a fortnight before he moved from the tent. I had not asked his name, nor did I ever ask his name. From the first I called him "sir," until it came to the time when I openly called him "Master." Strange though it may seem, from the first I knew that he had but to lift a finger and I would obey his behest. Nor do I think I ever departed from my manhood right in giving him such service.

It was a fortnight before he began to speak at any length, and in this silence it seemed that he rested his brain as deliberately as he did his tortured body. My two seamen, Higgins and Grumstock, accepted him as I did, and they almost fell over each other—or even out with each other—in their desire to do him service.

I shall not readily forget our first long talk, deep in the heart of the murmuring forest. It was night, and we were in the tent together, for we shared it now he was fit to walk abroad. I was putting some notes together of my observations in exploring, when suddenly he spoke.

"Seton," he said, "I am ready to talk if you are."

"Yes, sir," I said, as readily as though a talk had been prearranged. "I am ready."

It was a matter of turning my camp-chair to face him, and then he bade me tell him of my experience in the war of 1914-18. I had none of the hesitation I should normally have felt at obeying such a request. I told him all I had done from start to finish.

"Would you have it happen again?" he asked, when I had finished.

"No, sir," I said truthfully. "I hope we have seen the last of war forever."

"A vain hope, my good Seton," he said quietly. "The nations of the earth have forgotten. They have forgotten the bloodshed and ruin of those terrible years, the martyrdom of women, the sacrifice of men. Too quickly have they forgotten. Lust and anger sway them, and the greed of gain, jealousy of their neighbors. In their blindness they would repeat those awful years."

"I know," I said. "They are fools. I give them another three years—and some of them will be at it again. It will be bigger than ever. I knew my hope was vain when I expressed it, sir."

"Three years!" he said, half to himself. "It could be accomplished in three years." Then aloud: "Are you a rich man, Seton?"

"I have rather more than half a million English pounds."

"How much of that fortune would you give," he asked, "if it were guaranteed to you, beyond any possible doubt, that war could be stopped forever on this earth?"

"Every penny of it, sir," I said.

"And if I, Seton, if I offered you that guarantee?"

"Why, sir—I'd listen to you—I'd help——"

He looked at me in silence for a minute. From far away in the forest around us there came a deep boom as of a great bell suddenly smitten. What it was I cannot pretend to say, but the forest is like that. A great noise, quite inexplicable, then the silence once more, save for the never-ceasing whisper that hardly breaks the uncanny stillness.

"Seton," said the man earnestly, "I want your word that if you cannot believe what I shall tell you, if you cannot see your way clear to stand by my side—I want your word that you will never repeat a syllable of it to ears other than mine, that you will lock it up in your heart forever."

"I give you my word, sir."

Then the Master laid bare his plan to stop war.

Even now, with the years behind me when I worked by his side, my brain reels as I remember that night. Far into the night the Master talked, patiently explaining to my lay understanding secrets that have revolutionized science. He told of the mighty power which had come into his hand after years of endless labor, of picking up discarded threads at first thought useless, of following up paths of promise which ended in disappointment, and in the end of the discovery of a further path which even he with all his magnificent intellect dared not pursue to its end.

It was unbelievable—yet I believed. In the hollow of that frail hand, its fellow lost in indescribable suffering and torture in the search for that terrible secret, there lay the power to free mankind, or to destroy, to lay waste the whole earth—aye, and worlds beyond. I believed, but belief was agony.

Hour after hour he talked, in that tireless, untiresome level voice of his. A little man, frail, suffering the tortures of the damned from great cracking sores, yet placid, mild, gentle, with never a wince, never a smile even to mock his anguish. Years of Calvary lay behind him, and a quarter of a century of ceaseless toil. . . .

I say no living man could endure as the Master endured. As he spoke to me in the forest that night, I began to think that everything but the Will was gone; body, soul—everything which goes to make up the moving, whimpering, purposeless thing we call Man—everything but the Will. The Will and the Vision.

Yet, as I look back on the years that began that night, remembering the love I bore him, and the tender, winning, ungrudging, patient something that emanated from him to wrap me to him, I hope and pray that more than the Will was left.

"And so," he finished, "and so, my dear Seton, that afternoon when I opened my eyes and saw you, I believed that at last I had found my lieutenant. I believed that at last the path towards realizing my dream was opened for me. Are you the man, Sholto Seton? Think well, for here is the least I will take from you, the most I will offer you. Three years of belief, of unswerving devotion to my cause. Three years of unremitting toil, without reward except that

which will come from the cause itself. I offer you no more. I will take no less."

As I rose from my chair, my whole body was quivering and I was soaked in perspiration. I could not answer him. I reeled to the tent door and out into the open, then stumbled across the clearing to the riverside. I put my head on two hands crossed against a big tree, and, do what I might, I could not hold myself from a terrible dry sobbing.

When I lifted my head, a faint light was beginning to steal through the leaves overhead, and birds were beginning to chatter. I walked back to the tent. He was still in his chair, as though he had not moved.

"Well, Seton?"

"Yes, sir," I said—"if you'll have me."

"That is well," he said. "And now, my dear fellow, find what remnants of sleep you can. We must begin at once and I have much to tell you yet."

III

In the cool of the following morning we broke camp and set off on the long trek back to Manaos. Of the journey there is little of moment to tell. I had made my own arrangements for retiring from the wilderness, and they were fresher for being used a little earlier than I had anticipated. I had a bungalow outside the town of Manaos, and there I took the Master and my two men. I had paid off the bearers a good deal higher up the river, and we finished our journey on a power-boat of mine.

The wash-leather bag which I had thought contained geological specimens proved to have in it a collection of the finest rough Brazilian diamonds it has ever been my fortune to see. The Master, in the characteristically sparing way he had, simply stated that he had discovered a pipe of them in the higher reaches of the Negro, and his idea was that funds for beginning our work should come from the sale of these uncut gems. I had to go to Amsterdam to dispose of them, and it was also agreed that I should begin to liquidate my property by degrees, so that no suspicions would be aroused.

I left Grumstock with the Master at Manaos, and took Higgins with me to Europe, where, from a list provided me, I began to buy chemical and physical plants for the work the Master had to do. I had, in fact, to bring together all the instruments necessary for a small laboratory.

It was ten weeks before the liner dropped me and my stores at Manaos. I found the Master greatly recovered, and Grumstock very much installed as his body-servant, cook and housekeeper. Grumstock informed me quite gratuitously that he was ready to follow the owner—as he called our leader—anywhere. On this hint I found it expedient to outline the plan to my two old petty officers, and I was gratified to find them willing and eager to come into the scheme. Thus we had two good men, tried men, honest and handy, as a nucleus for our crew.

A few days after my return to Manaos we began our voyage up the river at a former base where I was friendly with a local headman. I was fortunate enough to secure a fine lot of bearers. Among the stores they carried were the sections of a good-sized canoe. Grumstock was an efficient carpenter, and the plan was to finish our journey by water, after he had put our little craft together. This plan, the Master assured us, was possible.

It was perhaps as well that the plan included the dismissal of our bearers when we took to the water, for as we approached the end of our portage, it became manifest that the Indians were growing restless and uneasy. I was afraid that they were about to desert us, and I searched for the reason of their unrest, but found the more intelligent of the bearers unwilling to talk. It was Higgins who brought me the clue.

"As far as I can make out, sir," he explained, "We're headin' due and proper for a place they call the Hill of Spooks. Another name they gave it is the Wound in the World. Accordin' to them niggers, there's a great, big, bloody scar in the body of the earth somewhere near 'ere, and every now and then you can hear the earth howlin' and groanin' wi' the pain from it. It was old Brass-bottle that told me about it, and a scared nigger he was too when he said it. I got it from him by degrees, like."

A Great Outcrop of Radio-Active Minerals and a Wonderful Cavern. The Discovery of a Strange Gas

I took this report to our leader.

"Yes, yes, Seton," he replied. "It is a point in our favor. The scar is there on the plateau, a red outcrop of radio-active minerals, which I hope to be able to use to some purpose. Nothing will grow on the outcrop, and at certain times of the year, water or wind through some underground passage of the plateau gives out a terrible howling. Hence the fear of the natives. But, as I say, a point in our favor, since we may work unmolested."

When we reached the water, the relief of the bearers at being dismissed was evident. We had no sooner freed them than they trooped off back the way we had come, and they were, I think, not a little scared for us.

The work of putting together our canoe occupied Grumstock and Higgins and myself less than a day, and when we had her in the water, we found her admirably suited for our purpose. She held our stores easily, and there was sufficient room left to afford our leader his ease—or as much ease as his poor body would allow him—together with space for the adequate handling of her.

In the early morning we set out for the mysterious plateau. I shall say nothing of the journey except that it was arduous.

Major Boon has given a fairly accurate description of the lay of the land about the plateau. Its main axis ran from east to west, and the toe lay among marshy ground, thickly grown with bladed plants and the myrtle and veronica type of shrub common in the district. On the north, a little basin lay under the plateau cliffs, and our approach was by a river which flowed from this basin, through a gorge quite navigable, and bore in a westerly curve from a cup of land of which the plateau was the southern border.

On the south side of the pleateau another river lay, or rather a backwater of that river which I shall call the Rio Innominata. We did not realize at our first approach of the plateau that it would have been possible to cut off several leagues of travel by making a portage to that backwater, of which both entrances were cut off from the main stream by a mass of fallen timber very much overgrown. We took, instead, the longer way. Out of the Rio Innominata at a good number of kilometers down stream from the backwater, we turned into the basin river, and described a wide loop to the north of the plateau. From the map it will be seen that both the Innominata and the stream from the basin in the northward cup flow west for the greater part of their courses, and that the former turns south at last to curve into an easterly running tributary of the Negro. In subsequent voyages the longer route I have indicated was always followed, and as a precaution against being detected, we left the overgrown entrances to the backwater undisturbed.

The basin to the north of the plateau was overhung by great limestone bluffs, which from the top must have hid half the basin's area, and this impending wall of rock was pierced by a great arch that led to a cave under the plateau, cave and basin being joined by water.

It was with a sense of awe, having lit the acetylene searchlight in the bows, that we began to paddle into the cave. The light but faintly illumined the vastness of the underground cathedral in which we now found ourselves. The ceiling was roughly arched, and in its shadowed height one imagined that a fantastic pattern of vaulting could be traced. Here and there, stalactite pillars of great girth gave color to the Gothic effect. We became conscious of the roar and plash of falling water, then deep in the heart of the cavern we came on a waterfall in which from a height of about forty meters a swift stream tumbled in great volume.

"By Jove! sir," I whispered to our leader, "what a chance there for power!"

"Yes," he replied. "But you will find the fall the least of the wonders I have to show you. Bear over to the right, Higgins, please."

I now saw that from the main cavern other caves ran out on either side, several of them with floors sloping clear of the water line. Two of these in particular, on the west, with a common mouth to the main cavern, were ideal for docking and building the airships which were part of our scheme. With our leader I went ashore to examine these two caves, and he led the way into an inner cave, rather smaller than the other pair.

"Here, Seton," he said, "we are standing, I am certain, on the down slope of an anti-clinal fold. See how it runs down under the basin of the main cavern. At the toe of the plateau, which I take to be the further slope of the saddle, I found among the marshes certain indications of the presence of petroleum—that greenish scum which I dare say you know——"

I nodded.

"Very well, then. If it can be avoided, we do not wish to drill for our oil in the open, but I think if we drill here we may do so with a reasonable hope of striking."

We passed round a wall of rock into another inner cave.

"If we block up this cave, having first made certain that there is no other outlet," said the Master, "don't you think, my good Seton, we shall have an adequate reservoir for our crude oil?"

"Why yes, sir," I replied, in bewilderment at the completeness of the thing. "A few bags of cement would put it right."

"Exactly. Now, on the other side of the main cavern there are other caves I should like to see. I am inclined to think that we shall have our refinery and machine shops over there. And I believe we shall find ample ventilation."

From the main mouth of the caves a ledge ran on the east side to widen out into a spacious floor on the left of the big central caves. This was so wide and deep that it was easy to picture an extensive machine shop there, with plenty of room left for the oil refinery. Our power was handy to it, for the waterfall was only a few paces round the corner of rock.

We paddled deeper into the cavern, and found that it extended the whole width of the plateau in a winding course of waterway. At the other side, the south, egress was given by an opening with little headroom to a small creek joining the backwater of the Rio Innominata. There was some flow of water from the fall to this outlet, but the main run was to the northern opening. The land about the plateau was very flat.

We returned and our leader showed the way into a cave near the main entrance on the west side. We had to climb into this cave, which was so close to the plateau side that light percolated through from the open by several cracks. The cave was one of a series on the same level, high and dry, and apparently well ventilated. These, it was easy to decide, would be the living quarters of the crew when it was formed.

While Higgins and Grumstock brought out stores into the living cave by means of a hastily rigged block and tackle, I found a pick-axe and began to widen one of the crevices to the open air. It was easy labor, for the rock here was friable, and I soon had hewn a biggish window permitting a view of the cup-like hollow to the north of the plateau. The stores were brought up. Grumstock and Higgins fell to setting out shipshape sleeping quarters, and presently to cooking a meal. We passed the night in better conditions than either the Master or myself had ever expereinced among the upper waters of the Amazon. We were thousands of miles from the nearest civilization, right in the heart of virgin forest, and as cut off from the knowledge of man as if we had been in another world.

In the morning, after an invigorating plunge and swim in the clear, cool waters of the cave, we set about forming a laboratory for our chief. We had no wood with which to set up benches, so we cut a deep ledge into one of the walls of the cave, and shovelled the débris out of the window opening. When we had made a good enough ledge to set out all the instruments and the plant our leader required, and had undercut it so that he could have comfort in standing close, we levelled the floor.

Meantime, the Chief had been exploring alone. Grumstock, with his ready wit, had fixed thole pins in the after part of the canoe's thwarts and had provided a long paddle-oar, so that the Master could maneuver the little craft with his single hand. He had been away several hours, and I was beginning to think it time I went in search of him, when he returned.

"Could you spare half an hour from your labors, Seton, to come with me?" he asked.

"Certainly, sir."

"I shall require a wide-necked bottle. Could you find me such a thing, Grumstock?"

"I dunno about a bottle, sir," the seaman said doubtfully. "What about a pickle-jar, sir?"

"Excellent—if it has a stopper?"

"Stopper, sir—yes, sir. It's got one of them that works with a lever—expanding thing, sir," said Grumstock, with an air of being meticulously accurate to the man of science.

The seaman washed the jar carefully, and with this and a bundle of candles we set out.

The New Gas is Light and Uninflammable

"I have found a light gas, Seton," the Master explained, "in one of the high caves beyond the fall. I was climbing up into it with the naked light of a candle, when suddenly I found difficulty in breathing and the candle went out. I quickly retreated, and now we are about to take a sample. I need your two hands and strong lungs."

We were paddling across the main cavern, and he stooped over the side to the water and filled the jar, which he carefully stoppered. We landed on the eastern side and began to climb into a sort of tunnel, he landing. We had mounted some distance when suddenly his candle went out and he came back hurriedly. We now were outside a smallish cave above the level, so I imagined of the main cavern roof.

"Now, Seton," the Chief said, "this is what I want you to do. Take the pickle-jar. How long could you hold your breath?"

"About half a minute, probably more."

"That will do. I want you to run up into the gas holding your breath. Raise the jar above your head and let the water pour out. Keep the jar mouth down, and as soon as it is empty of water, stopper it. Then come back as quickly as possible."

"I understand, sir."

"The idea is to get as far into the gas as is safe. Two steps higher when your candle goes out will do. Just see how long you can do without a breath."

I tested myself with the stop-hand of my watch, and found I could do forty-five seconds easily.

"Excellent. Now, don't run any risks. I'm not powerful enough to drag you out, you understand?"

"Right, sir. I'll take care."

I took the candle and the jar, and began to climb, holding the light over my head. As soon as the light went out, I dropped the candle and took a breath easily, then ran up about four paces. I let the water out of the jar as I held it up, and quickly replaced the stopper. I retreated with some wind to spare.

"Well done, Seton," cried the Master. "And now to see the nature of the gas. It is light and I should say inert."

We returned to the cave in the cliff, and spent the rest of the day in arranging the scientific instruments, helping our Chief to prepare for his first test of the gas. He explained that it could not be a thorough test, but that he might be able to determine the nature of the stuff.

That night I retired to the cavern where the two seamen slept, and turned in alongside them, leaving our leader working by lamplight.

In the early morning I wakened to find him standing by my bedside.

"Seton," he said. "I believe we have discovered a new light, uninflammable gas, and I think we may have enough to lift our airship. We have saved months of labor by the find. You must set out for Europe again as soon as possible."

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